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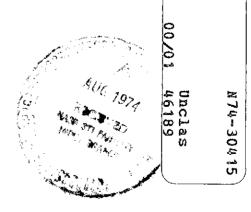
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AERONAUTICAL ENGINEERING

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Supplement 43

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 43

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in March 1974 in

- Scientific and Technical Aerospace Reports (STAR)
- International Aerospace Abstracts (IAA).



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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to Aeronautical Engineering—A Special Bibliography (NASA SP-7037) lists 421 reports, journal articles, and other documents originally announced in March 1973 in Scientific and Technical Aerospace Reports (STAR) or in International Aerospace Abstracts (IAA).

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, IAA Entries and STAR Entries in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in IAA or STAR, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes—subject, personal author, and contract number—are included. An annual cumulative index will be published.

AVAILABILITY OF CITED PUBLICATIONS

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc., (AIAA), as follows. Paper copies are available at \$5.00 per document up to a maximum of 20 pages. The charge for each additional page is 25 cents. Microfiche [11] are available at the rate of \$1.00 per microfiche for documents identified by the # symbol following the accession number. A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library. Minimum airmail postage to foreign countries is \$1.00. Please refer to the accession number, e.g., A74-11072, when requesting publications.

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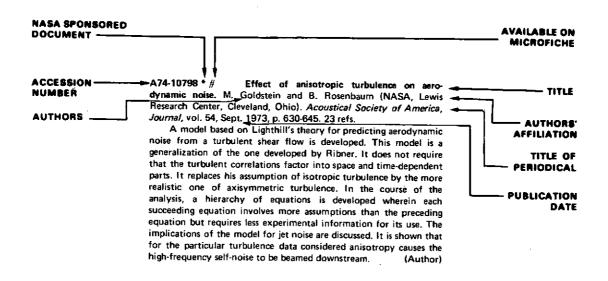
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TABLE OF CONTENTS

		Page
IAA Entries	***************************************	115
STAR Entries	***************************************	139
Subject Index		Δ.1
Personal Author Index	*************************	B 4
Contract Number Inde		
	C	
NASA SPONSORED DOCUMENT	CITATION AND ABSTRACT FROM S N74-10038*# Linguistic Systems. Inc., Cambridge, Mass.	TAR AVAILABLE ON MICROFICHE CORPORATE
TITLE	STUDY OF HEAVING MOTION IN AIR CUSHION VEHI- CLES G. VandeSteen Washington NASA Nov_1973 121 p_refs Transl. into ENGLISH from "Etude du Mouvement de Pilonnement des Vehicules a Coussin d'Air" Brussels, NT 33, 1973 97 p	SOURCE
AUTHOR —	(Contract NASw-2482) (NASA-TT-F-15106) Avail: NTIS HC \$8.25 CSCL 01C The behavior of three types of ground effect machines experiencing oscillations in vertical translation with no pitch roll	AVAILABILITY SOURCE
CONTRACT————	or yaw was studied. The configurations of the ground effect machines are described. It is shown that the two important movements in the problem are heaving and pitching, as yaw has virtually no effect of the performance of the vehicle. Preliminary	COSATI
REPORT————————————————————————————————————	tests showed that for all three types of vehicles, the transient state is in general an oscillating one, similar to a damped sinusoid. Author	

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AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 43)

APRIL 1974

IAA ENTRIES

A74-16384 Recent developments in sonic-boom simulation using shock tubes. J. J. Gottlieb and I. I. Glass (Toronto, University, Toronto, Canada). In: Recent developments in shock tube research; Proceedings of the Ninth International Symposium, Stanford, Calif., July 16-19, 1973. Stanford, Calif., Stanford University Press, 1973, p. 113-129. 19 refs. Research supported by the Canadian Transport Development Agency and National Research Council of Canada; Grant No. AF-AFOSR-72-2274.

Gasdynamic and acoustic analyses were performed in order to provide greater insight into the operation of sonic-boom simulators utilizing shock-tube drivers. Three basic shock tubes were considered; each had a pyramidal driver joined at the diaphragm station to a pyramidal channel of the same divergence angle (pyramidal shock tube), or of a different angle, or joined to a constant-area channel. Classical acoustic theory was applied to obtain new analytical solutions to describe the wave motion in such facilities, in agreement with experimental data. In addition, a detailed study of the nonlinear generation and propagation features of the N-wave was made for the important and practical case of the pyramidal shock tube. (Author)

A74-16385 Experimental investigation of sonic boom propagation through variable flow fields. W. L. Harris, Sr. (MIT, Cambridge, Mass.). In: Recent developments in shock tube research; Proceedings of the Ninth International Symposium, Stanford, Calif., July 16-19, 1973. Stanford, Calif., Stanford University Press, 1973, p. 130-143. 15 refs. Research supported by the Massachusetts Institute of Technology; NSF Grant No. GK-5772.

The effects of thermodynamic gradients and flow curvature on the propagation of sonic boom signatures have been investigated experimentally. The gradients and flow curvature have been generated by inserting a series of movable deflection steps in the test section of a supersonic wind tunnel. The centered expansion which is produced as the supersonic flow expands over the deflection steps agrees to within 2% of theory. Sonic boom pressure signatures are generated by a series of bodies of revolution with varying degrees of nose bluntness placed within and ahead of the centered expansion fan. Depending upon the intensity of the gradients and position of the sonic boom source, the sonic boom may or may not decrease in width as it propagates through the nonuniform flow region. Trends in peak-to-peak overpressure and maximum overpressure have been noted with the gradients tending to enhance or at least to maintain the level of these quantities as the sonic boom propagates through (Author) the nonuniform flow region.

A74-16445 Manufacturing exercise involved in the redesign of the Hawker Siddeley Trident /tri-jet/ fuselage, J. Fielding (Hawker Siddeley Aviation, Ltd., Woodford, Ches., England). In: Titanium science and technology: Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume New York, Plenum Press, 1973, p. 45-52.

Three particular areas were chosen for evaluation, viz., the sheet/stringer/frame structure in the keel area, the upper fuselage, and a window panel area. The usual attention was given to fatigue strength, critical crack length, and residual strength. Fusion welding was used whenever practicable, i.e., for skin to stringer joints and panel butt welds, with a little electrical resistance spot welding for the frame to fuselage skin attachment. The weight savings possible with titanium design as compared with an aluminum structure amounted to 23.6% overall on the complete fuselage section. Chemical milling, through welding under tension, welding on the tension draw welding machine, and vacuum hot sizing are discussed.

A74-16446 The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier. H. J. Sayer (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, England). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 53-56. Research sponsored by the Ministry of Defence.

A74-16447

B-1 cost/weight trade methodology, R. E. Edmonson and W. A. Reinsch (North American Rockwell Corp., Los Angeles, Calif.). In: Titanium science and technology; Proceedings of Angeles, Calif.). In: Titanium science and technology; Proceedings of Angeles, Calif.). In: Titanium science and technology; Proceedings of Angeles, Calif. In: Titanium science, Cambridge, Mass., May 2-5, 1972. Volume 1.

New York, Plenum Press, 1973, p. 57-68.

A development is described which provides the capability for detailed subsystem selections based on cost/weight to a degree of credibility not previously obtainable. The process is based on the comparison of the weight differentials of competitive subsystem elements, converting these differentials to dollar value, and then evaluating these dollar values along with the detail acquisition cost estimate of the candidate design. This cost/weight trade study methodology has provided early visibility for potential cost and risk problems, and is considered a strong management tool for design decisions. In general, the structural components using titanium are required to be cost/weight effective, and to exhibit high fatigue life, good fracture toughness, and be relatively damage-tolerant. Annealed 6AI-4V was selected for these applications.

A74-16448 Design and development support for critical helicopter applications in Ti-6Al-4V alloy. P. R. Wedden (Westland Helicopters, Ltd., Yeovil, Somerset, England) and F. Liard (Société Nationale Industrielle Aérospatiale, Marignane, France). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.

New York, Plenum Press, 1973, p. 69-80. 5 refs.

The Lynx multiservice helicopter embodies a semirigid rotorhead and an electron beam welded transmission drive shaft in Ti-6AI-4V alloy. This alloy was chosen on the basis of some degree of previous design experience, weldability, a large background of semifinished product know-how, multinational alloy production, and a general lack of manufacturing problems. An attempt is made to show the role and activity of a binational, interdisciplinary approach culminating in the utilization of 570 kg of titanium alloy forging and bar stock, which represent 5 percent all-up weight of the development aircraft. Basic design requirements, basic material and process evaluation, electron beam welding, surface processing, grinding, pin fretting, and section size and microstructure are discussed. F.R.L.

A74-16449 Flat rolled beta titanium alloys for airframe application. G. A. Lenning and W. H. Heil (Titanium Metals Corporation of America, Toronto, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, p. 81-89.

The beta alloy Ti-8Mo-Ti-8V-2Fe-3Al was selected for full-scale evaluation as continuous strip after examination of many compositions at the laboratory and development stages, and confirming that it could be melted by the conventional consumable electrode vacuum arc process. Processing details and mechanical properties of a production size heat processed by continuous strip methods are given. The alloy shows producibility and property characteristics that make it ideally suited for airframe applications such as honeycomb core and face sheets, welded tube and ducting, firewalls, bulkheads, stringers, skins, and miscellaneous formed parts. On a strength to density basis it will match or exceed the more popular Ti-6Al-4V alloy and at a lower unit cost.

A74-16450 Applications of the high strength alloy Ti-4Ai-4Mo-2Sn-0.5Si in European aircraft projects. R. M. Duncan and R. T. J. Hubbard (Imperial Metal Industries /Kynoch/, Ltd., Birmingham, England). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 91-103.

A74-16451 Titanium - The bridge to composites. L. R. Sanders, R. S. Baxter, and R. J. Juergens (McDonnell Aircraft Co., St. Louis, Mo.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 105-117.

The continuing demand for higher performance and lighter weight aircraft structure has led to the development of new lightweight composite materials possessing great strength. Sufficient confidence has been developed in high strength resin matrix composites such as boron/epoxy to permit their use in primary aircraft load carrying structure. Weight studies have shown that a very significant 20% weight reduction can be achieved through the use of composites in empennage control surfaces. This is an application that has been made possible primarily because of the compatibility of these composites with titanium, which is unique in its ability to be efficiently coupled with composite materials. It is titanium that permits the composite to be effectively joined to the conventional metal airframe. Full-scale composite empennage hardware is currently in production, and this advancement has been achieved by employing titanium as an integral part of the composite design.

A74-16476
Failure experience with and failure anticipation in titanium components. B. Cohen, H. M. Burte, and D. M. Forney, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.

New York, Plenum Press, 1973, p. 679-692.

A variety of service failures in titanium components is described, and some of the factors involved in these failures are discussed. The reviewed case varieties include fretting, titanium-ignition, and

fatigue-induced failures, as well as a case of silver-induced cracking. The possibilities of failure anticipation in titanium components are also considered.

M.V.E.

A74-16477 Effects of Ti-6Al-4V alloy metallurgical structures on ultrasonic response characteristics. F. R. Billman and F. F. Rudolph (Alcoa Technical Center, Pittsburgh, Pa.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.

New York, Plenum Press, 1973, p. 693-705.

A74-16479 Ultrasonic inspection of titanium airframe components. K. L. Kremer, R. J. Lord, and R. J. Roehrs (McDonnell Aircraft Co., St. Louis, Mo.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 717-731.

Review of ultrasonic defect-detection techniques used for ensuring the internal integrity of titanium aircraft components. Following a discussion of defect origins and varieties, and consideration of the prerequisites to ultrasonic inspection effectiveness, the establishment of acceptance criteria and the implementation of ultrasonic inspection procedures are treated. General ultrasonic considerations include sound transmission characteristics, surface curvature compensation, and near-surface resolution. Special attention is given to the particular inspection requirements of forging stock, die forgings and preforms, plates, and bars. Ultrasonic inspection changes caused by fracture mechanics are also examined.

M.V.E.

A74-16480 Non-destructive inspection of titanium jet engine disks. F. J. Vicki (United Aircraft Materials Engineering and Research Laboratory, Middletown, Conn.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1.

New York, Plenum Press, 1973, p. 733-741.

Discussion of the material defects encountered and the non-destructive inspection techniques employed with the Ti-6AI-4V alloy used in the production of jet engine compressor disks. The defect categories considered include: (1) interstitial segregation, (2) chemical segregation, (3) high-density inclusions, and (4) clean porosity. Reviewed inspection methods include radiography, surface inspection, ultrasonic techniques, and the blue etch anodize method.

M.V.E.

A74-16482 Nondestructive detection of hydrides and alpha-case in titanium alloys, D. J. Hagemaier (Douglas Aircraft Co., Long Beach, Calif.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 1. New York, Plenum Press, 1973, p. 755-765.

Search for practical nondestructive tests to reliably measure rejectable levels of hydrogen and alpha-case in titanium alloys before parts or materials are manufactured or placed in service. A performed experimental evaluation of ultrasonic-attenuation, eddy-current, and thermoelectric tests is reviewed, and the results are discussed in terms of the capabilities and limitations of each test variety.

M.V.E.

A74-16513 High cycle fatigue properties of titanium in aircraft application. W. J. Crichlow (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and T. Lunde (Lockheed-California Co., Burbank, Calif.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 2. New York, Plenum Press, 1973, p. 1257-1270. 13 refs.

The high-cycle spectrum fatigue properties of a number of alloys and product forms of titanium are discussed primarily from the viewpoint of aircraft usage. Constant load amplitude S-N type data

and the more realistic variable load amplitude spectra type data are reviewed. It is shown that titanium responds to variable load amplitude fatigue spectra in a manner similar to aluminum and steel, requiring very careful consideration of realistic spectrum type fatigue tests and special care in modifications of real spectra for laboratory test economics. If titanium is to remain competitive in the future, major improvement in high-cycle fatigue properties and reduction of scatter must be achieved by more stringent control of all steps of production, processing, and finishing, including tighter controls on heat-treatments, on grain size, oxygen, and other interstitial trace elements to which fatigue crackling is sensitive.

A74-16554 Development of cold headable titanium alloys for the 'Concorde' supersonic jet. E. Alhéritière, C. Drapier (Trèfimétaux GP, Argenteuil, Val-d'Oise, France), R. Molinier, and R. Syre (Trèfimétaux GP; Titanium GP, S.A., Argenteuil, Val-d'Oise, France), In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 3. New York, Plenum Press, 1973, p. 1929-1943.

Three of seven titanium alloys studied meet the requirements for fabrication of cold headable rivets for the supersonic Concorde Jet. The three alloys include Ti-2.5 Cu X (low oxygen grade), Ti-1 Al-1.5 V (low oxygen grade), and Ti-X (Ti with controlled oxygen content around 0.13 percent). Careful analysis of the results has shown that in the range of compositions studied the strengthening effect of oxygen of forty times that of vanadium and aluminum and sixty times that of copper and iron. However, the decrease in strength resulting from an increase of temperature (20 to 120 C) is somewhat more important with the oxygen strengthened grade. Due to this slight disadvantage and, above all, to the need for precise control of oxygen content, the Ti-X grade has been finally adopted.

A74-16559
Deep hardenable titanium alloys for large airframe elements. E. Bohanek (Titanium Metals Corporation of America, Toronto, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 3.

Plenum Press, 1973, p. 1993-2008.

The development of improved titanium-base alloys for heavy sections is reviewed from the earliest commercial metastable beta alloy Ti-13V-11Cr-3Al to the latest innovations. The latest commercial metastable alloy Ti-8Mo-8V-2Fe-3Al exhibits improved fracture toughness, more abbreviated and predictable aging cycles, but also poorer transverse tensile ductility. Practical means are suggested for improving transverse ductility. The near beta alloy Ti-10V-2Fe-3Al is shown to exhibit good heat response in heavy sections with improved tensile ductility even without achieving the desired microstructural grain refinement. Noted improvements over earlier developments are the markedly improved machinability, the decrease in density, and increase in density, and increase in tensile modulus for Ti-10V-2Fe-3Al.

A74-16579 Dynamic creep of titanium alloy with 1.5 wt % Mn and 3% Al in high-velocity air streams. I. N. Bogachov, U. G. Veksler, and V. G. Sorokin (Ural'skii Politekhnicheskii Institut, Sverdlovsk, USSR). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 4. New York, Plenum Press, 1973. p. 2269-2278. 7 refs.

The transient creep of the Ti-3Al-1.5Mn alloy in a high-velocity air stream differs greatly from that in static air. The time before failure is 10 to 30 times shorter in the stream, plasticity being 2-3 times lower. Creep resistance in a rapid air stream will decrease considerably with increasing test temperature, angle of attack, and flow velocity. This is connected with changes in properties, composition, and structure of the material surface layers due to corrosion and erosion effects of the air stream. The nucleation of pittings,

particularly at grain boundaries, contributes to accelerated weakening and failure of the alloy.

T.M.

A74-16592 Fretting resistant coatings for titanium alloys.
D. J. Padberg (McDonnell Aircraft Co., St. Louis, Mo.). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972. Volume 4.

New York, Plenum Press. 1973. p. 2475-2486

New York, Plenum Press, 1973, p. 2475-248 Contract No. F33615-70-C-1538.

Investigation of the safe use of fretting-resistant coatings for the prevention of fretting-induced fatigue failures in aircraft components made of titanium alloys. The specific study goals explored and results presented pertain to: (1) the determination of fretting conditions prerequisite to fatigue life shortening in a titanium airframe joint; (2) evaluation and selection of potential fretting-resistant coatings that would not impair the properties of the basis metal; and (3) test of promising fretting-resistant coatings on experimental test elements using the critical fretting conditions determined under (1).

M.V.E.

A74-16600 * Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation. H. R. Gray (NASA, Lewis Research Center, Cleveland, Ohio). In: Titanium science and technology; Proceedings of the Second International Conference, Cambridge, Mass., May 2-5, 1972, Volume 4.

New York, Plenum Press, 1973, p. 2627-2638. 15 refs.

A74-16696 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap joints. J. P. Sandifer (Lockheed-California Co., Burbank, Calif.). Wear, vol. 26, Dec. 1973, p. 405-412. 7 refs.

Fatigue strength of aluminum lap joints subjected to fretting can vary widely, depending on the type of treatments applied to the faying surfaces. Many materials normally selected for their lubricity or good wear properties cannot be used in a bolted joint because of their interference with the load transfer requirements of the joint. Thus the best methods found in this evaluation in order of their effectiveness were bonded and shot-peened, bonded alone, shot-peened alone, and bonded steel wear pads. These techniques increased the fatigue strength at 10,000,000 cycles of an untreated joint from 12 ksi to a maximum of 23 ksi. (Author)

A74-16727 On the problem of rain erosion on a moving body flying at supersonic speed (Über das Problem der Regenerosion bei einem mit Überschallgeschwindigkeit bewegten Flugkörper). W. Körner (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für angewandte Mathematik und Mechanik, Freiburg im Breisgau, West Germany). Acta Mechanica, vol. 18, no. 1-2, 1973, p. 103-115. 6 refs. In German.

When a body flying at supersonic speed approaches a liquid droplet, before impinging at the stagnation point the latter is exposed to the flow field in front of the body. The aerodynamic forces acting on the droplet reduce its impact velocity and also change its shape. Based on a suitable model, formulas for the rate of erosion at the stagnation point during the impact are derived in terms of dimensionless quantities describing the flight conditions. (Author)

A74-16755 # A 300 B static and fatigue tests. F. W. Vann (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). Aircraft Engineering, vol. 45, Dec. 1973, p. 6-8, 10.

The required testing is broken down into the three main categories of static strength testing, fatigue testing, and fail safe and residual strength testing. The loads to be applied to the specimen to simulate an actual flight case consist of fuselage inertia and aerodynamic, wing aerodynamic and inertia, tailplane aerodynamic and inertia, and fuselage pressurization loads, and miscellaneous

loads including inertia loads on the engines, and aerodynamic loads on the engines and their supporting pylons, etc. The sequence of testing of the static speciment is described in detail. F.R.L.

A74-16756 # Lasers - Ranger and marked target seeker. S. D. Lazenby (Ferranti, Ltd., Hollinwood, Lancs., England). Aircraft Engineering, vol. 45, Dec. 1973, p. 11.

The laser ranger and marked target seeker is essentially an air to ground device designed to augment the current generation of aircraft inertial navigation and attack systems. The laser provides instantaneous and extremely accurate range, which is one of the most important parameters to be established prior to a successful weapon strike. The laser ranger and marked target seeker normally comprises two units: the stabilized main unit, contained in a pressurized canister, and an electronics unit which is made up of power supplies and circuit cards.

F.R.L.

A74-16758 # Models in the design of fuel systems. W. J. Rix (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). Aircraft Engineering, vol. 45, Dec. 1973, p. 14-17.

The use of scale fuel system models is discussed, a procedure used by Hawker Siddeley coupled with a small amount of rig testing. The construction of the models is described and some of the techniques evolved for solving specific fuel system problems are outlined. The problems of designing an aircraft fuel system break down into two basic categories. One is the problem of predicting and controlling the behavior of the fuel in the system pipework; the other is the problem of predicting and controlling the behavior of the fuel within the tanks. Tank venting, the positioning of refuel cut-off sensors, contents gauging, and the determination of unusable fuel conditions are discussed. Particulars of the Trident 3 and A300B Airbus fuel systems are given.

A74-16760 # Titanium flamecutting reduces airframe costs.
H. M. Gallagher (British Oxygen Co., Ltd., London, England).
Aircraft Engineering, vol. 45, Dec. 1973, p. 20, 21.

Oxy gas flamecutting is based on the fact that when mild steel and titanium is raised to a temperature of about 800 C, it burns readily in the presence of oxygen. Oxy-fuel gas heating flames from the cutting nozzle maintain the combustion temperature while oxygen fed from the same nozzle maintains combustion and blows away the combustion products. Rate of cutting depends on the type and thickness of the material being cut, on fuel gas and pressure used. The height of the burner above the plate and other factors are also important, but given correct setting, perfectly smooth cuts can be produced in material up to 10 in, thick as routine, and more than 30 in, thick by skilled operators.

A74-16793 YF-16 stresses advanced technology. E. J. Bulban. Aviation Week and Space Technology, vol. 100, Jan. 7, 1974, p. 40-44, 47, 48.

The philosophy underlying the design and development of General Dynamics' YF-16 highly maneuverable light-weight 'dog-fighter' airplane that could complement the USAF/McDonnell Douglas F-15 Eagle and provide USAF with the numbers and tactical flexibility needed to counter large fighter forces. The approach adopted was that goals of low cost and high degree of combat maneuverability would be achieved by building the smallest lightest airplane possible, and integrating advanced technology that promised low risk. Aerodynamic technologies include a variable-camber wing, vortex lift, relaxed static stability component of a control-configured vehicle with fly-by-wire control system, wing-body blending, and underbelly engine inlet system.

V.P.

A74-16822 # Buckling loads and minimum weight of compressed curved ribbed aluminum alloy panels (Carichi di cedimento e peso minimo di pannelli curvi nervati compressi in leghe di alluminio). G. Gabrielli and A. Ravetti. Torino, Accademia delle Scienze, Classe di Scienze Fisiche, Matematiche e Naturali, Atti, vol.

107, July-Oct. 1973, p. 499-513. 37 refs. In Italian, Research supported by the Consiglio Nazionale delle Ricerche.

Results of a study concerning the determination of the compressive strength of curved aluminum alloy panels stiffened with riveted ribs. These results, together with others obtained from the specialized literature, were processed and are represented in a unified form in order to facilitate a comparative study and to derive an envelope curve of the maximum buckling stress as a function of the structural load index, thus making it possible to choose, during the design stage the solution most suited to the weight effects. It is shown that the ratio between the weights of two panels which are made of the same material, have the same dimensions, and yield under the same load is given by the reciprocal of the respective buckling stresses for each value of the structural load index. Thus it is possible in the preliminary design of an aircraft to evaluate the minimum weight of the structures with a good approximation.

A.B.K.

A74-16898 Noise burden factor - New way of rating airport noise. E. J. Richards and J. B. Ollerhead (Loughborough University of Technology, Loughborough, Leics., England). Sound and Vibration, vol. 7, Dec. 1973, p. 31-33, 5 refs.

It is shown that the relative benefits and disadvantages which an airport offers to its neighboring community can be evaluated with the aid of a criterion termed the noise burden factor. This measure represents the days of serious noise nuisance to one house dweller for each passenger or freight unit arriving at or leaving the airport. The noise burden factor is shown to provide a convenient means for comparing noise problems at different airports and for monitoring the effectiveness of noise control measures over a period of time.

T.M

A74-16951 * Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings. F. R. Bailey (NASA, Ames Research Center, Moffett Field, Calif.) and W. F. Ballhaus (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2. Berlin and New York, Springer-Verlag, 1973, p. 2-9. 6 refs.

The mixed elliptic-hyperbolic relaxation method for obtaining steady-state solutions to two-dimensional transonic potential equations is extended to the transonic small disturbance equation in three dimensions. In particular, transonic flow is considered both about nonlifting wing-cylinder combinations and over thin lifting wings with sweep and taper. The treatment is restricted to freestream Mach numbers less than one and to wings with subsonic trailing edges.

M.V.E.

A74-16963 A direct method for computing the steady flow at Mach number one past a given wing airfoil, D. Euvrard and G. Tournemine (Rennes, Université, Rennes, France). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2.

Berlin and New York, Springer-Verlag, 1973, p. 146-152. 8 refs. Research supported by the Direction des Recherches et Moyens d'Essais,

The structure of a steady inviscid fluid flow past a convex airfoil at M 1 is described as one containing a purely subsonic region that extends from infinity upstream down to the sonic lines, a region containing two narrow supersonic strips bounded upstream by the sonic lines, a region consisting of two supersonic flow fields whose downstream boundaries are formed by shock waves at the trailing edge, and a region with a complex structure behind the shock waves. A procedure is proposed for calculating the velocity distribution this flow.

A74-16965 * Calculation of separated flows at subsonic and transonic speeds. J. M. Klineberg and J. L. Steger (NASA, Ames Research Center, Moffett Field, Calif.). In: International Conference

on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July Rerlin and 3-7, 1972, Proceedings, Volume 2. New York, Springer-Verlag, 1973, p. 161-168. 7 refs.

A boundary-layer integral approach is combined with a finitedifference relaxation method to calculate viscous interactions between separated flows at subsonic and transonic velocities. Results are obtained for separated laminar flows on circular-arc airfoils at zero angle of attack and are compared with data of Collins (1972). Inviscid and viscous flows are covered.

Development of a method of discretized-A74-16968 distribution singularities for the study of compressible and incompressible flows (Developement de la méthode des singularites à répartition discrétisée pour l'étude des écoulements incompressibles et compressibles). T.-S. Luu and G. Coulmy (CNRS, Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July 3-7, 1972, Proceedings. Volume 2. Berlin and New York, Springer-Verlag, 1973, p. 184-190. 13 refs. in French.

A relexation method for calculating transonic A74-16970 * flows with detached bow shocks. E. M. Murman (NASA, Ames Research Center, Moffett Field, Calif.). In: International Conference on Numerical Methods in Fluid Mechanics, 3rd, Paris, France, July Berlin and 3-7, 1972, Proceedings. Volume 2. New York, Springer-Verlag, 1973, p. 201-205. 9 refs.

The use of Murman and Krupp's (1971) method for calculating steady, inviscid, transonic flows with imbedded shock waves is discussed in application to two-dimensional problems for transonic flows past sharp and moderately blunt nosed geometries. A relaxation algorithm is used to solve the equations,

Reduction of vibration and noise generated by planetary ring gears in helicopter aircraft transmissions. T. Chiang and R. H. Badgley (Mechanical Technology, Inc., Latham, N.Y.). (American Society of Mechanical Engineers, Mechanisms Conference and International Symposium on Gearing Transmissions, San Francisco, Calif., Oct. 8-12, 1972, Paper 73-PTG-11.) ASME, Transactions, Series B · Journal of Engineering for Industry, vol. 95, Nov. 1973, p. 1149-1158. 8 refs. Army-supported research.

Narrow-band studies of the noise generated by rotor-drive gear boxes indicate the presence of a number of very high narrow noise peaks located at gearbox mesh frequencies or their multiples. Exceptions are sideband noise components, located so near the main signal component as to be indistinguishable except for very narrow band reduction. An approach to the treatment of this type of noise is described which is based on systematic studies of the flow of high-frequency vibration energy in the drive train, aimed at determining the mechanism by which gear meshes generate vibrations, and examining the vibration response of the gearbox components supporting the gears. Calculations for two representative rotor-drive gearboxes are performed, and the possibility of noise reduction by modification of ring-gear casing design is studied.

Refrigerated containerized transport for A74-17007 'Jumbo' jets. L. Tyree, Jr. (Liquid Carbonic Corp., Chicago, III.). In: Progress in refrigeration science and technology. Volume 4.

Westport, Conn., AVI Publishing Co., Inc., 1973, p.

515-525; Discussion, p. 525. 6 refs.

The technology and economics of refrigerated containerized sirfreight transportation by wide-bodied, double-decked 'Jumbo' jets are reviewed. In addition to the all-freight versions, the so-called passenger versions of these jets are true combination passenger-cargo aircraft, each with lower hold cargo capacities up to 40,000 lbs, ideally suited for shipments of perishables in self-contained refrigerated containers. Once these containers are loaded with freight and charged with dry-ice refrigerant, they require no further service or

special handling throughout the in-transit time. It is expected that these new transportation techniques will have a substantial effect upon current freight traffic practices by creating new traffic patterns and new markets.

Lifting-surface theory for an oscillating T-tail. A74-17012 # K. Isogai (National Aerospace Laboratory, Tokyo, Japan). AIAA Journal, vol. 12, Jan. 1974, p. 28-37, 17 refs.

A lifting-surface theory for predicting aerodynamic forces on an oscillating T-tail is presented with special reference to the effects of tailplane dihedral and tailplane incidence. The analysis is confined to the incompressible flow case. By introducing a new coordinate system oscillating coincidentally with the in-plane motion of the tailplane and by employing a perturbation technique, the boundary. value problems are derived. The integral equations for the prediction of the antisymmetric load distributions on the tailplane, which are induced by the in-plane motion of the tailplane, are derived from the second-order boundary-value problem, while the first-order problems are those of conventional lifting-surface theories. A method for solving the integral equations is proposed, and the working forms of these equations are given. Some numerical examples for simplified T-tails are given and are compared with the experimental results. The theory is found to be useful for predicting the effects of tailplane dihedral and tailplane incidence on the flutter speed of a T-tail.

(Author)

A vortex entrainment model applied to slender A74-17029 * # delta wings. P. L. Coe, Jr. (NASA, Langley Research Center, Joint Institut for Acoustics and Flight Sciences, Hampton, Va.; George Washington University, Washington, D.C.). AIAA Journal, vol. 12, Jan. 1974, p. 110-112. 10 refs.

A mathematical model of the vortex flow over a slender sharp-edged delta wing is proposed, and is shown to provide good agreement with the experiment. Although the technique requires experimental data in the form of the vortex core locations, it does account for the previously ignored mass entrainment of the vortex

Transonic transport wings - Oblique or swept. A74-17048 * # R. T. Jones (NASA, Ames Research Center, Moffett Field, Calif.) and J. W. Nisbet (Boeing Commercial Airplane Co., Renton, Wash.). Astronautics and Aeronautics, vol. 12, Jan. 1974, p. 40-47. 6 refs.

A comparative evaluation of fixed-geometry and variable-sweep wing designs, a fixed delta wing, and oblique wings with a single body or two bodies suggests that an oblique wing is preferable in a transonic transport aircraft in terms of gross weight, fuel consumption, and aircraft noise, and also shows an acceptable aeroelastic stability. Further studies are, however, needed to develop the full potential of the oblique-wing concept, including its economic implications.

Putting all our noise technology to work. R. P. A74-17049 * # Jackson (NASA, Office of Aeronautics and Space Technology, Washington, D.C.). Astronautics and Aeronautics, vol. 12, Jan. 1974, p. 48-51.

An assessment of the present state of the art in noise reduction technology indicates that this technology has the potential for effectively attaining this goal - a conclusion that is in apparent conflict with the frequently voiced complaints on intolerable noise levels near airports. Measures are suggested for a more vigorous implementation of available technology in practice to combat the V.Z. aircraft noise problem.

Ablation, H. Hurwicz and J. E. Rogan A74-17103 (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: New York, McGraw-Handbook of heat transfer. Hill Book Co., 1973, p. 16-1 to 16-64, 124 refs.

Heat and mass transfer phenomena occurring in the ablation process are described, with emphasis placed on hypersonic flight. Various regimes involved in ablation are explained in terms of mass removal caused by thermochemical and mechanical processes, the response of the material to the environment, the mechanisms by which the material absorbs heat, boundary layer phenomena, and mass and energy balance at the surface. A comprehensive review is given of currently employed mathematical treatments of the thermochemical response of ablators which are surface coupled to a hypersonic, compressible, reacting, viscous flow field with a possibility of mass injection.

T.M.

A74-17175 # Noise and emission outlook for military engines. D. W. Bahr, R. Lee, R. P. Taylor, and J. E. Worsham (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). Canadian Aeronautics and Space Institute and American Institute of Aeronautics and Astronautics, Aeronautical Meeting, Montreal, Canada, Oct. 29, 30, 1973; AIAA Paper 73-1156. 8 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

Progress of technology in noise and exhaust gas and smoke discharge reduction in military engines is reviewed and further efforts needed in this field are considered with the emphasis on the reduction of NO(x), CO, and hydrocarbon emissions. Recommendations are given as to how R&D should be continued to meet the required standards.

A74-17177 # Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example (Vergleichende Untersuchung verschiedener Flugkörper-Antriebe am Beispiel einer Schiff-Schiff-Lenkwaffe). G. Heise. Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt. Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-068. 32 p. 5 refs. In German.

Design study illustrating the process of selection of the most suitable propulsion system for use in a hypothetical air-to-air missile under various circumstances. The propulsion systems considered include a low-cost turbojet engine with and without an afterburner, an improved ramjet engine, a second-generation pulse jet, solid-fuel engines, and solid-fuel ramjet rockets. The efficiencies and the costs of each type of propulsion system are taken into account, as well as fuel data. On the basis of curves for the initial mass and engine costs, an unequivocal relation can be obtained between engine type and missile range.

A.B.K.

A74-17178 # Some results of an experimental study of the Aerodyne concept by Dornier System GmbH (Einige Ergebnisse der Experimentalstudie der Dornier System GmbH zum Aerodyne-Konzept). W. Melzer (Dornier-System GmbH, Friedrichshafen, West Germany). Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Weltraumforschung Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-069, 12 p. In German.

Results of an experimental study concerned with laying the groundwork for the development of an unmanned flight vehicle which combines a hover capability with the high-speed performance of jet aircraft. The results of thrust and efficiency measurements on the experimental Aerodyne El flight vehicle are presented, as well as the results of wind-tunnel tests on an electrically driven simplified model of the vehicle, and the results of hover-flight tests of the vehicle with respect to attitude stabilization, behavior during landing, and maneuverability.

A.B.K.

A74-17179 # Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle (Auslegung und Erprobung im Schwebeflug eines Lenkregelsystems für den flügellosen, ferngelenkten Experimentalflugkörper Aerodyne). U. Schulz (Dornier-System GmbH, Friedrichshafen, West Germany). Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesell-

schaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-070, 30 p. In German

Description of the design and testing of a hover flight controller for a vehicle which combines VTOL properties with a high flight speed capability. This flight controller is designed in such a way that the hover flight state can be maintained by an attitude control along the pitch and roll axis and a coarse course maintenance along the yaw axis. In order to improve the hover capability, translational damping in the x- and y-direction is employed. The transfer functions of the controller and the controlled plant are determined on the basis of simulation studies, and the dynamic behavior of the uncontrolled and controlled Aerodyne is assessed on the basis of a root locus analysis.

A74-17185 An analytic approximate calculation of the nonlinear landing impact motions and loads on aircraft with both rigid and elastic wing structure (Eine analytische Näherungsrechnung zu den nichtlinearen Landestossbewegungen und -belastungen am Flugzeug bei starrer sowie bei elastischer Flügelstruktur). W. Hagemann (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). Österreichische Gesellschaft für Weitraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-078. 89 p. 14 refs. in German.

A74-17186 # Supersonic flow past sharp- and blunt-nosed conical bodies at angles of attack from 0 to 45 deg (Überschall-Umströmung von spitzen und stumpfen Kegelkörpern im Anstell-winkelbereich von 0 bis 45 deg). W. Langefeld (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). Österreichische Gesellschaft für Waltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-080. 69 p. 9 refs. In German,

Results of experimental studies of supersonic flow in the nose region of a truncated cone and a cone with a spherical nose. The studies performed concern the shock contour and the location of the shock front in the angle-of-attack plane, the behavior of the boundary line between the subsonic and supersonic regions in the neighborhood of the body in the angle-of-attack plane, and the pressure distribution on the body surface, as measured in the angle-of-attack plane and in the plane of the body symmetry axis. Existing methods of calculating the flowfields for sharp- and blunt-nosed cones at zero angle of attack are reviewed. In addition, approximate methods for determining the pressure distribution or shock contour at angle of attack are discussed, and their usefulness for application to the investigated family of conical bodies is ascertained.

A.B.K.

A74-17187 A method of designing supercritical lift profiles (Entwurfsmethode für auftriebsbehaftete überkritische Tragflügelprofile). J. Scheerer and B. Kiekebusch (Messerschmitt-Bölkow-Blohm GmbH, Hamburg, West Germany). Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-081. 43 p. 22 refs. In German.

Description of a method of designing supercritical lift profiles in which the desired solutions are obtained by matching with so-called basic profiles. It is shown that by applying methods of subsonic theory to supercritical basic profiles determined by Nieuwland's method (1964) supercritical solutions can be obtained for which the flow properties on the upper side of the profile are largely similar to those of the chosen basic profile. As a result, supercritical profiles of various thicknesses can be prepared for a given design Mach number by variation of the geometrical parameter influencing the profile thickness. By matching the pressure distribution on the upper side to a given 'target pressure distribution' while causing the minimum

possible change in the contour, a collisionless recompression is sought on the upper side of the profile, which has now become a lift profile.

A.B.K.

A74-17192 Designing with plastic resin matrix composite materials (Entwerfen mit Kunstharzmatrix-Verbundwerkstoffen). C. Schulze (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-086. 27 p. 7 refs. In German.

Consideration of the advantages and disadvantages of the use of plastic resin matrix bonded or mechanically joined composite materials. The possibilities and problems of designing large structural components out of such composite materials are indicated on the basis of existing design engineering experience. The potential advantages in using these composite materials are contrasted with the difficulties arising when laboratory results and materials theories are applied to the constructive shaping of large structural components. A practical procedure for the empirical development of design criteria to supplement the theory in different problem situations is illustrated by examples. Finally, examples of composite material structures used in fighter aircraft are cited and discussed.

A.B.K.

A74-17205 # Problems in data management for earth monitoring missions (Probleme beim Data Management für erdbeobachtende Missionen). E. Velten (Dornier-System GmbH, Friedrichshafen, West Germany). Osterreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Dautsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-109. 37 p. 6 refs. In German. Bundesministerium für Forschung und Technologie Contract No. RVII-V17/72-KA-15.

Consideration of the problems connected with the handling of large quantities of data (generally in the form of images) obtained by aircraft and spacecraft during earth-monitoring missions. A parametric study is made of the problems connected with data acquisition, onboard data processing, data transmission, ground station data processing, and data evaluation by the user. Considering various sensor platfoms such as buoy- and ground-based measurement networks, aircraft, satellites, and unmanned spacecraft, the various measurement procedures which could theoretically be used for earth monitoring are discussed with reference to the possibilities of onboard data processing and the preparation of the data for transmission to the ground station. In connection with data processing at the ground station, the basic problems of processing large quantities of data, especially image data, are indicated, and methods of solution are suggested. The possibilities of user-oriented data evaluation are indicated on the basis of characteristic examples such as texture analysis and change detection.

A74-17216 Automatic control aspects of a control configured aircraft with allowance for maneuver load control (Regelungstechnische Aspekte eines Flugzeuges künstlicher Stabilität /CCV/ unter besonderer Berücksichtigung der Manöverlaststeuerung). W. Kubbat (Messerschmitt Bölkow-Blohm GmbH, Ottobrunn, West Germany). Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, DGLR Paper 73-121. 28 p. In German.

Review of automatic control problems arising in the design of a type of advanced aircraft called control-configured vehicles. Among the problems discussed are the control of unstable aircraft, maneuver load control, gust alleviation, flutter suppression, and new controlled variables. Examples are presented which give insights into the possibilities of the control-configured vehicle. It is shown that the problem of gust alleviation/maneuver load control cannot be treated as an isolated problem, and the concept of an integrated total control of the elastic aircraft is derived. This task includes both the control

of rigid body forms and the addition of elastic forms of motion. It is shown that by the use of the elastic description of the surface in the treatment of the aircraft control stresses can be reduced and lifetime increased at the price of increasing expenditure on sensors, more complex signal processing, and the amalgamation of safety-determining and nonsafety-determining signal paths.

A.B.K.

A74-17221 # The jet-flapped wing in ground proximity with special allowance for large angle of attack and large jet flap angle (Der Strahlklappenflügel in Bodennähe unter besonderer Berücksichtigung grosser Anstell- und Strahlklappenwinkel). R. Löhr. Österreichische Gesellschaft für Weltraumforschung und Flugkörpertechnik and Deutsche Gesellschaft für Luft- und Raumfahrt, Gemeinsame Jahrestagung, 6th, Innsbruck, Austria, Sept. 24-28, 1973, Paper. 19 p. In German.

Investigation of the effect of the ground on an aircraft wing with jet blowing at the trailing edge. The method of singularities is used to calculate the inviscid plane flow past such a jet-flapped wing, with the ground being represented by mirror imaging. The problem leads to a system of nonlinear integral equations for the singularity distributions which also contains the initially unknown jet behavior. The system is solved numerically by an iterative method. The theory yields the pressure distribution, the jet behavior, the lift, and the moment as a function of the angle of attack, the jet flap angle, the blowing momentum, and the distance from the ground. The general (i.e., nonlinear) theory developed is found to show significant improvements over the linear theory, which is valid only for small angles of attack and small jet flap angles.

A.B.K.

A74-17252 New concepts in AMTI radar - Nulling effects of Doppler filter/multi-element horn array. W. B. Goggins, C. J. Sletten, and F. S. Holt (USAF, Cambridge Research Laboratories, Bedford, Mass.). *Microwave Journal*, vol. 17, Jan. 1974, p. 29-33, 35.

New concepts for Airborne Moving Target Indicator Radar are described which exploit recent advances in optimum null formingbeam forming antennas and in real-time electronic digital processing of radar signals. This scheme makes use of contiguous fixed antenna beams covering a wide azimuthal sector from an aircraft and a complementary Doppler-filter processor which together with antenna nulls reject ground clutter. A coherent post detection beam forming scheme operates simultaneously with each Doppler channel and intergrates many target pulses to provide high signal to clutter ratios. Because the system does not require periodic pulsing, range ambiguity problems are reduced. A comparison with the displaced phase center and other AMTI methods is made. Some experimental efforts are described. The objective is to design airborne radar for detecting other aircraft against ground-clutter background with a modern, simple radar having an antenna composed of fixed radiating elements that can be flush mounted. (Author)

A74-17270 Nonlinear airfoil theory with allowance for ground effects (Nichtlineare Tragflügeltheorie in Bodennähe). D. Hummel (Braunschweig, Technische Universität, Braunschweig, West Germany). Zeitschrift für Flugwissenschaften, vol. 21, Dec. 1973, p. 425-442. 38 refs. In German.

As the basis for the solution of aerodynamic interference problems the complete field of induced velocities is calculated according to lifting line theory as well as to lifting surface theory for wings with a plane vortex sheet and with given load distribution. Lifting surface theory turns out to be in good agreement with experimental data, particularly in the vicinity of the wing. Using these results for the wing in ground proximity, the extended lifting line theory and the lifting surface theory are applied by means of the image technique. Plane vortex models parallel to the ground as well as inclined to the ground are used and calculations are performed with and without taking into account the longitudinal components of the induced velocities, produced by the image wing. This leads to lift and pitching moment coefficients which depend nonlinearly on

the angle of incidence. If the inclination of the wing against the ground and the longitudinal components of the induced velocities are considered simultaneously, the corresponding nonlinear lifting surface theory is in excellent agreement with experimental data.

(Author)

A74-17272 Problem of adapting an intake to a turbojet engine for extremely high flight Mach numbers (Zum Problem der Anpassung eines Einlaufs an ein Turbotriebwerk für extrem hohe Flug-Machzahlen). H. Künkler (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). Zeitschrift für Flugwissenschaften, vol. 21, Dec. 1973, p. 445-453, 5 refs. In German.

After brief presentation of the possible types of a supersonic intake and its operational behaviour, the fundamental difficulties occurring during operation of a turbojet engine with a fixed geometry intake are shown and possibilities of elimination are studied. Design criteria and the influence of central body displacement are discussed using as example the design of a two-shock diffuser for a turbojet engine (ATAR-9). Finally, an intake with fully variable geometry for extremely high flight Mach numbers is planned for a turbojet engine which seems to be suitable for the propulsion of an aerodynamic spacecraft launcher. The possibility and/or necessity of adaptation by varying geometry, by air addition in the thrust nozzle and by speed control of the engine is investigated. (Author)

A74-17276 # The Type 3B attitude measurement system. A. N. Du Feu. Aviation Review, Oct. 1973, p. 8-11.

The Type 3B system is a modern comprehensive altitude measurement system which combines high accuracy with an ambiguous counter/pointer presentation, together with facilities for altitude reporting and alerting, and correction of static pressure error. A unique design feature of the altimeter enables very simple transducers to be employed. The components are described briefly and comments are made of the system operation, in order that the maximum efficiency may be obtained.

F.R.L.

A74-17277 # The impact of area navigation on flight control systems and displays. D. J. Mayes. *Aviation Review*, Oct. 1973, p. 14-16.

More stringent navigational requirements in terms of accuracy must have accompanying requirements for integrity to guard against gross errors. The duplicated area navigational systems available today can provide both the navigational accuracy and integrity of information but the integration of automatic flight control and instrumentation with these systems needs careful consideration to ensure that the total system, including the crew, is capable of utilizing this increased accuracy and integrity to provide a safe transport system with decreased pilot work load.

F.R.L.

A74-17305 # Emission of gaseous pollutants by turbojet engines - The Olympus case (Emission des pollutants gazeux par les turboréacteurs - Application à l'Olympus). A. Quillevere and J. Decouflet (SNECMA, Paris, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings. Paris, COVOS, 1973, p. II-1 1 to II-1 26. 5 refs. In French.

Discussion of the pollution problems associated with the use of afterburners with turbojet engines on commercial aircraft particularly in the case of the Olympus engine under such flight conditions as during takeoff, acceleration in transonic flight, and climb in supersonic flight. The topics reviewed include optimum combustion prerequisites and design requirements, mechanisms of pollutant formation, pollution-characterizing parameters, pollution emission by the turbojet engine and the afterburner, pollution characteristics of the Olympus engine, high-altitude pollution during afterburning, and pollution-reducing devices.

A74-17306 # Particle sampling and size analysis in the ejection zone of the Olympus jet engine at ground level (Prélèvements et analyses granulométriques dans la zone d'ejection du réacteur Olympus au niveau du sol). G. Madelaine and D. Vigla (Commissariat à l'Energie Atomique, Service Technique d'Etudes de Protection et de Pollution Atmosphérique, Fontenay-aux-Roses, Hauts-de-Seine, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings. Paris, COVOS, 1973, p. II-3 1 to II-3 9. In French.

Description of the techniques employed in obtaining particle samples in the jet stream of a jet engine, and review of the analytical procedures used in determining the collected particle concentration, size, and composition. Some preliminary experimental results are presented.

M.V.E.

A74-17311 # Temperature, winds, and turbulence at SST flight levels (Température, vent et turbulence aux niveaux de vol des SST). P. Le Berre (Météorologie Nationale, Paris, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings.

Paris, COVOS, 1973, p. VI-3 1 to VI-3 11. In French. Review of the results of stratospheric wind and temperature studies by balloon-borne experiments performed up to 40-km altitudes in recent years. These results indicate the existence of two stratosphere layers: the upper one, where the 'east wind phenomena' (i.e., abrupt temperature rises and the stratospheric monsoon) take place, that is governed by the overlying levels; and the lower one, where SSTs are to operate, and which is governed by the underlying tropopause. The boundary between these two layers lies at an altitude of 20-22 km. The lower stratosphere exhibits a very thin-layered structure and is characterized by 'accidents' or discontinuities in its wind and temperature profiles that may last for more than 12 hrs and extend over several hundred kilometers. Some of the problems entailed by these discontinuities are discussed.

M.V.E.

A74-17312 # Stratosphere contamination by aircraft and mathematical models (Injections stratosphériques par avionset modèles mathématiques). R. Joatton and J. Bensimon (Société Nationale Industrielle Aérospatiale, Direction Technique Avions, Paris, France). In: Franco-British Seminar on the Consequences of Stratospheric Flights, Paris, France, March 22, 23, 1973, Proceedings.

Paris, COVOS, 1973, p. VII-4 1 to VII-4 12. In French.

Mathematical models pertaining to turbulence and pollutant diffusion, as well as to calculations of the relations with the environment of aircraft crews and passengers, and aircraft emissions, are discussed. Some of the preliminary results obtained from applications of these mathematical models to hypothesized Concorde-type aircraft traffic are presented and discussed. These order-of-magnitude results have been obtained without making any allowance for the undoubtedly important effects of dissociation and disappearance of the various emission products concerned and must be viewed with appropriate reservations.

M.V.E.

A74-17374 Materials for the new generation of aircraft. M.
A. Steinberg. In: The science of materials used in advanced technology.
P. 461-508, 20 refs.

Materials for the new generation of aircraft. M.
New York, Wiley-Interscience, 1973, p. 461-508, 20 refs.

Discussion of materials applications in aircraft, and examination of aircraft design requirements as related to strength and fatigue resistance to afford an insight into the problems of selecting materials for structural applications. The modern materials available for long-life, high-performance applications in aircraft are noted. The tradeoffs between material properties such as strength, fracture toughness, resistance to stress corrosion cracking, yield of minimum-weight structures, and ensurance of fail-safe design without premature failure are described. New developments in high-strength aluminum alloys to accomplish these tradeoffs are discussed. The effects of minor amounts of alloying elements in aluminum alloys,

the control of certain impurities, the thermomechanical processing treatments, and the newer overaging treatments to improve stress corrosion resistance, while maintaining adequate strength, fracture toughness, and tear resistance, are cited. The status of titanium technology as it applies to subsonic aircraft is discussed. Advantages and shortcomings, not only for aircraft structures, but also for engine applications, are illustrated. Finally, the development of new advanced high-strength steels and improvements in melting and processing practices are touched upon.

A.B.K.

A74-17495 Characteristics of the wake behind a cascade of airfoils. R. Raj and B. Lakshminarayana (Pennsylvania State University, University Park, Pa.). Journal of Fluid Mechanics, vol. 61, Dec. 18, 1973, p. 707-730. 16 refs. Navy-sponsored research.

An analytical and experimental investigation of the near and far wake characteristics of a cascade of airfoils is reported in this paper. The measurement of mean velocity, turbulence intensity, and Reynolds stress across the wake at several distances downstream of the cascade indicates that the wake is asymmetrical and that this asymmetry is maintained even up to 3/4 of chord length. Experiments carried out at three incidences reveal that the decay of the wake defect is strongly dependent on the downstream variation of the wake edge velocity. For a cascade, the decay rate of the wake defect is found to be slower than that of a flat plate, cylinder, or symmetrical airfoil (at zero incidence). The level of turbulence and Reynolds stresses are found to be high, and some comments are made regarding self-preservation and structure of the flow. (Author)

A74-17531 Avionics design for maintainability - Are we gaining or losing. T. A. Ellison (United Air Lines, Inc., Chicago, III.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730882. 9 p. Members, \$1.25; nonmembers, \$2.00.

An overview of avionics maintainability, as indicated from airline operating statistics, shows improvement in some elements and degradation in others, but a slowly degrading overall trend. Maintainability elements and trends are identified and discussed. Principal problems are the shop labor expended for the high proportion of removed equipment found to be in satisfactory condition, and the increasing line maintenance effort required by wide-body aircraft. Built-in test equipment (BITE) or monitoring within the system, if properly designed, appears to be a good approach to improve this situation. Design guidance for effective BITE or monitoring objectives is provided. (Author)

A74-17532 L-1011 upkeep. W. H. Spannuth (Trans World Airlines, Inc., Kansas City, Mo.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730883. 8 p. Members, \$1,25; nonmembers, \$2.00.

The question has been asked whether the airline industry is gaining or losing in the design of new aircraft for maintainability. The Lockheed L-1011 aircraft is examined by an operator resulting in two answers: yes for routine maintenance and no for nonroutine maintenance. Areas for investigation for further improvement, particularly in the wide-body aircraft, include the care of passenger cabin and associated appliances and amenities. The airlines have increased interior maintenance by brightening up the interiors trading dark colors, which do not show abuse, for the lighter, more attractive colors. The same principles and criteria need to be applied to cabin interior design as have been used to develop the reliable structures, systems, and powerplants now in operation.

A74-17533 Wing fuselage structural/concept study for a subsonic transport aircraft. G. V. Deneff (Douglas Aircraft Co., Long Beach, Calif.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper' 730886. 16 p. 5 refs. Members, \$1.25; nonmembers, \$2.00. Contract No. F33615-72-C-1450.

Results of a brief study program to devise and evaluate new structural materials and concepts for a subsonic, transport-type aircraft are presented. Comparisons of several wing concepts to the state-of-the-art baseline concept indicate a weight saving of 10%, but with corresponding total cost increases of 50-75%. One fuselage concept indicates a 7% weight saving with a 5% total cost saving. Corresponding aircraft performance payoffs with and without resizing are also established. Both baseline and new concept analyses are based on a common set of requirements for ultimate strength, fatigue life, damage tolerance, and flutter rigidity. The study is directed to metallic concepts. (Author)

A74-17534 Application of advances in structures and materials to the design of the YF-17 airplane. R. D. Hayes (Northrop Corp., Los Angeles, Calif.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730891. 8 p. Members, \$1.25; nonmembers, \$2.00.

A review of the structural design and material selection in the YF:17 airplane is presented. Emphasis is placed on the choice of those design concepts and materials that are unique, and the effect on these choices of the prototyping philosophy is described. Special emphasis is placed on the use of graphite materials, but the use of other nonmetallic materials and the considerations involved in the selection of metallic alloys and heat treatments are also discussed.

(Author)

A74-17535 An approach toward optimizing material cost and part function in advanced powerplants. R. W. Stusrud, E. S. Nichols, B. A. Zolezzi, and D. K. Hanink (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif.; Oct. 16-18, 1973, Paper 730909. 8 p. Members, \$1.25; nonmembers, \$2.00.

This paper describes the recent and successful features of an intensive program to control the costs of advanced military aircraft gas turbine engines in line with the costs of current production engines and of those produced during the past several years. We have been attempting to incorporate highly advanced technology into our new products, while at the same time holding the costs in line with older technology products. In many instances, we have been able to use the advanced technology to lower costs at the same time that weight and performance are improved. There are examples of this in aerodynamics, mechanical design, and materials and processes. In other instances, the experience is more conventional, in that lower costs involve increases in weight; in these cases, lists of weight increases versus cost decreases are maintained, and the most attractive concepts are incorporated up to the acceptable weight (Author) limits of the engine specification.

A74-17536 The T700-GE-700 turboshaft engine program. W. J. Crawford, III (General Electric Co., Aircraft Engine Group, Lynn, Mass.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730917. 14 p. Members, \$1.25; nonmembers, \$2.00.

The 1500 SHP T700 engine is being developed for the U.S. Army UTTAS and AAH helicopters. Prototype engines have been running well since testing began early in 1973. Qualification is expected in early 1976, Engine history and current details, design features, program milestones and possible future developments are reviewed. The unique T700 design will achieve unusually high levels of reliability and maintainability.

A74-17537 Heavy Lift Helicopter main engines. D. R. Woodley (Boeing Vertol Co., Philadelphia, Pa.) and W. S. Castle (General Motors Corp., Detroit Dieset Allison Div., Detroit, Mich.). Society of Automotive Engineers, National Aerospace Engineering

and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730920. 19 p. Members. \$1.25: nonmembers. \$2.00

The Heavy Lift Helicopter (HLH) is the airborne component of a container ship and helicopter logistics system. This paper describes powerplant aspects of the HLH program, including engine sizing, selection, and development of the Detroit Diesel Allison 501-M62B engine for the test rig. The current development program for XT701-AD-700 flight engines for use in the HLH prototype is discussed.

A74-17541 Development of requirements for, and evaluation of, manufacturer advanced design aircraft. J. D. Graef (American Airlines, Inc., New York, N.Y.). Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730948. 15 p. Members, \$1.25; nonmembers, \$2.00.

A74-17542 Data acquisition, processing, and control for advanced aircraft. H. E. Sutherland. Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 16-18, 1973, Paper 730957. 8 p. Members, \$1.25; nonmembers, \$2.00.

The advanced system monitor (ASM) is an integrated display device using digital data acquisition and processing techniques, and is intended for a new generation of transport aircraft. It provides the flight crew with the critical airplane condition data in one centralized location. The equipment described constitutes the data acquisition, processing, and control portion which works in conjunction with the ASMs electronic display. The mechanization is a dual redundant system having operational modes which allow for the safe flight of aircraft even if there are two failures. The heart of the system is a general-purpose computer which monitors and, on command, provides the crew with aircraft condition status and automatically notifies of deteriorating conditions so that an appropriate action can be taken.

A74-17736 Dynamic test of air data computers with simulated flight profiles (Dynamische Prüfung von Luftwerterechnern mit simulierten Flugprofilen). W. Schöfer (Telefunken AG, Konstanz, West Germany). Internationale Elektronische Rundschau, vol. 27, Dec. 1973, p. 270-272. In German.

An air data computer is used for the determination of important data which are required to provide the necessary flight safety to the aircraft. Atmospheric parameters are measured with the aid of sensing devices. The parameter values are supplied to the air data computer. The determination of the atmospheric conditions is discussed together with details regarding the measurement of the parameters and the functions of the air data computer. The objectives of the testing system are examined along with its principles of operation.

G.R.

A74-17739 # The use of fully stressed iteration and structural index in automated structural optimization. L. Spunt (California State University, Northridge, Calif.). SAWE Journal, vol. 33, Dec. 1973-Jan. 1974, p. 11, 12, 21, 10 refs.

Consideration of a generalized iteration scheme applicable to a large number of variables in automated optimization of structural components. The scheme is similar to that given by Gellatry (1966) but incorporates structural index data without the necessity of determining internal loads. The steps of the iteration scheme are described.

V.Z.

A74-17740 # Utility analysis in weight control. P. F. Halfpenny (Lockheed-California Co., Burbank, Calif.). SAWE Journal, vol. 33, Dec. 1973-Jan. 1974, p. 15-18.

Consideration of a method for combining weight, reliability, control stability and cost criteria into a single compatible value which represents the utility criterion for the selection of an optimal

system design from system weight analysis and evaluation program. Effective temperature and weight are discussed as utility criteria in application to the L-1011 Environmental Control System. Different types of sample juries participated in experiments conducted in different cities across the nation in the evaluation of these criteria.

V.Z.

A74-17776 Vehicle crashworthiness, S. P. Desjardins (Ultrasystems, Inc., Phoenix, Ariz.). In: Numerical and computer methods in structural mechanics.

Academic Press, Inc., 1973, p. 557-584, 6 refs.

Aircraft crashworthiness is discussed, with special attention to survivable crash environments for rotary-wing aircraft, light fixed-wing aircraft, and fixed-wing transport aircraft. It is shown that vehicles can be designed to provide crash protection to occupants at relatively little penalty to vehicle weight and cost, and that seating and restraint systems should have the strength required to remain in place until the surrounding structure collapses.

M.V.F.

A74-17801 Improvement of the downflow conditions behind an integrated shrouded propeller (Verbesserung der Abströmverhältnisse hinter einer integrierten Mantelschraube). C. Kramer, H.-J. Gerhardt (Aachen, Fachhochschule, Aachen, West Germany), and H. Fischer (Rheinflugzeugbau GmbH, Mönchengladbach, West Germany). Flug Revue/Flugwelt International, Jan. 1974, p. 23-25. In German.

A74-17804 # Automatic balancing of an aircraft (Automatyczne wywazanie samolotu), A. Groszek. *Technika Lotnicza i Astronautyczna*, vol. 28, Dec. 1973, p. 4-9. In Polish.

The longitudinal balancing of an aircraft in flight is explained by reviewing the operation of a trimming tab on the elevator. Automatic trimming systems are described where the trimmer is operated either by an input signal proportional to the load on the elevator mechanism or by input signals generated with mechanical position sensors. The Concorde system of fuel allocation in balancing tanks is briefly outlined.

T.M.

A74-17806 # A color schlieren system. T. J. Kessler and W. G. Hill. Photographic Applications in Science, Technology and Medicine, vol. 9, Jan. 1974, p. 22-24, 34, 5 refs.

Description of a color schlieren system to be used in studies of separated compressible fluid flows in supersonic wind tunnels. To achieve a color schlieren system, the conventional knife edge is replaced by a tri-color filter. The details of operation of the proposed color schlieren system, using a red-blue-yellow filter, are indicated. Excellent results have been obtained using the color schlieren system with both 35-mm still photographs and 16-mm high-speed motion pictures. Both photographic applications employ an auxiliary lens placed after the knife edge to refocus the test section image in the plane of the film.

A.B.K.

A74-17810 * # Airborne profiling of ice thickness using a short pulse radar. R. S. Vickers (Colorado State University, Fort Collins, Colo.), J. E. Heighway, and R. T. Gedney (NASA, Lewis Research Center, Cleveland, Ohio). Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., Dec. 2-6, 1973, Paper. 10 p. 6 refs.

This paper describes helicopter-borne measurements of ice thickness in Lake Superior, Lake St. Clair, and the St. Clair river as part of NASA's program to develop an ice information system. The profiler described is a high resolution, nonimaging, short pulse radar, operating at a carrier frequency of 2.7 GHz. The system can resolve reflective surfaces separated by as little as 10 cm and permits measurement of the distance between resolvable surfaces with an accuracy of about 1 cm. Data samples are given for measurements both in a static (helicopter hovering), and a traverse mode. Ground

truth measurements taken by an ice auger team traveling with the helicopter are compared with the remotely sensed data and the accuracy of the profiler is discussed based on these measurements.

(Author)

A74-17851 # Nonstationary vibrations of a rigidly supported flexible rotor of variable mass (Nestatsionarnye kolebaniia gibkogo rotora s peremennoi massoi na zhestkikh oporakh). E. Rakhimov. Mekhanika Mashin, no. 39-40, 1973, p. 80-91. 6 refs. In Russian.

Transient processes generated in a rotor system by simultaneous changes in the rotor mass and spin rate are analyzed with and without allowance for gyroscopic effects. The equations of the flexural vibrations of a rotor of variable mass are derived and are solved by an asymptotic method due to Bogoliubov and Mitropolskii (1964).

V.P.

A74-17856 # New jumbo jets must speak in whispers - Certifying the Lockheed 1011. N. Shapiro and J. W. Vogel (Lockheed-California Co., Burbank, Calif.). Noise Control Engineering, vol. 1, Summer 1973, p. 16-23. 7 refs.

The L-1011-1 noise certification program is described, covering instrumentation, test site, data reduction and analysis, FAR Part 36 demonstration for the Federal Aviation Administration (FAA) and results. FAR Part 36 establishes effective perceived noise levels to be met at three reference locations. The central recording systems used includes a 14-channel FM tape recorder with low-level, differential inputs, oscilloscope monitoring, and Lockheed-built attenuators. Although FAR Part 36 only specified actual takeoffs and landings for demonstrating noise, for L-1011 certification a series of level flyovers was also conducted at heights above the runway of approximately 400 and 800 feet. The results of these level flyovers were used to confirm the noise vs engine parameter relationship developed in the course of the flight test program.

A74-17862 An aircraft exterior coating system and surface pretreatment. S. Tsukada, S. Sagata, K. Saito, and T. Kitagawa. *Mitsubishi Juko Giho*, vol. 10, no. 3, 1973, p. 430-440. 7 refs. In Japanese, with abstract in English.

Polyurethane paints were tested for evaluation of their properties in comparison with those of lacquer and alkyd enamel paints which have been generally used for aircraft exterior coating, in an attempt to plan a manufacturing program of polyurethane paints having excellent properties as aircraft exterior coating materials. Polyurethane paints were found to be superior to lacquer and alkyd enamel paints expecially with respect to resistance to weather, to contamination, and to synthetic lubricating oil. A flight test of the polyurethane coating on a supersonic aircraft over one year demonstrated its sufficient capabilities under operational conditions. The pretreatment of aircraft surfaces, which has significant effects on the adhesion and corrosion resistance of coatings, was also evaluated, and the relationship between the coating adhesion and the condition of the pretreatment film, such as heat deterioration, aging, and (Author) surface retreatment, was clarified.

A74-17887 Aircraft components from remelted steels - Design and development (Pièces aéronautiques en aciers refondus - Réalisations et développement). M. Rabbe (Creusot-Loire, Unieux, Loire, France) and M. Rambaud (Creusot-Loire, Pamiers, Ariège, France). I Journée d'Etudes sur l'Amélioration des Performances des Aciers à Température Ambiante et à Haute Température, 5th, Le Bourget, Seine-St.-Denis, France, June 1, 1973.) Matériaux et Techniques, vol. 61, Apr. May 1973, p. 101-110. In French.

The serial production of high-quality landing gear and airframe steel components processed through remelting in consumable-electrode furnaces, under vacuum, or electroslag is reviewed. It is shown that the quality and variety range of products obtainable by

these processes affords the designer choices adjustable to any set of safety requirements at the optimum cost efficiency compromise.

M.V.E.

A74-17890 Status of the latest turbine disk alloys in the U.S. (Point des alliages avancés pour disque de turbine aux U.S.A). J. E. Coyne and W. H. Couts (SNECMA, Gennevilliers, Hauts-de-Seine, France). (Journée d'Etudes sur l'Amélioration des Performances des Aciers à Température Ambiante et à Haute Température, 5th, Le Bourget, Seine-St.-Denis, France, June 1, 1973.) Matériaux et Techniques; vol. 61, Apr.-May 1973, p. 147-155. 9 refs. In French.

Review of recent advances in the production technology of aircraft turbine disks made of conventional and hot-die forgings from powder-metallurgy processed René 95 and In 100 billets. The thermomechanical treatment techniques used are shown to offer the designer the possibility to meet the stringent requirements of turbine components.

M.V.E.

A74-17891 Heat-resistant titanium alloys - Introduction of the 651 A alloy (Les alliages de titane résistant à chaud - Présentation de l'alliage 651 A). L. Séraphin, R. Tricot, and R. Castro (Ugine Aciers, France). Matériaux et Techniques, vol. 61, Apr.-May 1973, p. 156-171. 35 refs. In French. Research supported by the Services Techniques de l'Aéronautique.

Review of the principal thermomechanical characteristics of the new 651 A alloy that has been derived from the older 685 titanium alloy and possesses comparatively improved quenching properties. These improvements are shown to make possible its use in jet engine compressor disks.

M.V.E.

A74-17892 Evolution of applications of precision casting in turbojets (Evolution des applications de la fonderie de précision dans les turboréacteurs). R. Brunetaud (SNECMA, Bois-Colombes, Hauts-de-Seine, France). (Journée d'Etudes sur l'Amélioration des Performances des Aciers à Température Ambiante et à Haute Température, 5th, Le Bourget, Seine-St.-Denis, France, June 1, 1973.) Matériaux et Techniques, vol. 61, Apr.-May 1973, p. 172-177. In French.

A74-17898 * Recent studies of tire braking performance. J. L. McCarty and T. J. W. Leland (NASA, Langley Research Center, Hampton, Va.). (American Society for Testing and Materials, Symposium on Tire Traction, Lanham, Md., May 10, 1972.) Tire Science and Technology, vol. 1, no. 2, 1973, p. 121-137.

The results from recent studies of some factors affecting tire braking and cornering performance are presented together with a discussion of the possible application of these results to the design of aircraft braking systems. The first part of the paper is concerned with steady-state braking, that is, results from tests conducted at a constant slip ratio or steering angle or both. The second part deals with cyclic braking tests, both single cycle, where brakes are applied at a constant rate until wheel lockup is achieved, and rapid cycling of the brakes under control of a currently operational antiskid system.

(Author)

A74-17905 # The hydrogen fuel economy and aircraft propulsion. A. L. Austin (California, University, Livermore, Calif.) and R. F. Sawyer (California, University, Berkeley, Calif.). American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 9th, Las Vegas, Nev., Nov. 5-7, 1973, AIAA Paper 73-1319. 6 p. 20 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. AF-AFOSR-72-2299.

Considerable interest has been directed toward the use of hydrogen as an ultimate replacement for fossil fuels. It is clean burning at comparable thermal efficiencies in piston and turbine engines, exists as a huge resource, and since the primary combustion product is water, the cycle from ecosphere to use and back to ecosphere is probably measured in years rather than millions of years as is the case with fossil fuels via the carbon cycle. The other

fundamental advantage is that energy storage per unit weight is less than fossil fuels, and therefore hydrogen is an attractive fuel for aircraft. Large new sources of hydrogen at a low price are required before hydrogen can play an important role as an aircraft fuel. F.R.L.

A74-17969 Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Annual Report 1972 (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Jahresbericht 1972). Porz-Wahn, Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, 1973. 452 p. In German.

Activities in the field of fluid dynamics are reported together with investigations in the areas of the mechanics of flight, mechanical strength, materials, and design methods. Propulsion systems are considered, giving attention to aerial jet propulsion, chemical rocket propulsion, electrical propulsion, plasma dynamics, reaction kinetics, fuels, and lubricants. Other activities discussed are in the fields of electronics, space physics, space medicine, computers, aeronautics, and astronautics.

A74-17984 Innovations in ATC communication systems.

R. Wainwright (FAA, Washington, D.C.). In: National Telecommunications Conference, Atlanta; Ga., November 26-28, 1973, Conference Record. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 7C-1 to 7C-3.

Advances and innovations in air traffic communications since the early 1920s are reviewed and shown to have been evolutionary in the sense of successive generations identifiable in relative time frames. The present status of development is defined, and current trends and goals for the future are discussed.

M.V.E.

A74-18050 Military and aerospace. D. Mennie. IEEE Spectrum, vol. 11, Jan. 1974, p. 71-77,

Space age know-how is being used to solve immediate problems that the general public is facing, such as safe landing at congested airports. As a complement to airport radar the Air Traffic Control Radar Beacon System (ATCRBS), currently in widespread operation, provides the ground controller with aircraft position, identity, and altitude data. But the growing number of beacon-equipped aircraft and ground interrogators and the inherent self-interference limitations of the ATCRBS have motivated the development of hardware called the Discrete Address Beacon System (DABS). Coupled with a reshuffling of national priorities, space exploration has shifted to the task of providing an efficient means of performing routine missions. The technology which permitted a NASA scientist in Houston to control a TV system on the moon could make practical a defense concept that saves both men and money.

F.R.L.

A74-18083 # The problem of optimal design of gas-turbine engines (K voprosu ob optimal'nom konstruirovanii gazoturbinnykh dvigatelei). N. D. Kuznetsov. *Problemy Prochnosti*, vol. 5, Nov. 1973, p. 55-60. In Russian.

Consideration of the stages of development of a new gas-turbine engine, and analysis of examples of optimization of various structural strength components. After briefly defining the concept of optimal design of an engineering structure, an attempt is made to determine the principles and methods which should underly an optimal design and the criteria which are to serve as the basis for evaluating optimality, and an optimal design scheme, constructed on the basis of the main stages of design of a gas-turbine engine, is proposed. Some examples of the design of engine subassemblies which are optimal from the strength standpoint are then presented, stressing the use of the theory of limiting equilibrium in achieving optimal design of heavily loaded subassemblies and components of gasturbine engines, the use of the principle of maximum damping, and the use of methods of strengthening components.

A.B.K.

A74-18085 # A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in (Issledovanie powrezhdaemosti turbinnykh Iopatok aviatsionnykh GTD posle ekspluatatsionnoi narabotkil. B. A. Griaznov, S. S. Gorodetskii, and A. S. Tugarinov (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR). Problemy Prochnosti, vol. 5, Nov. 1973, p. 65-67. 5 refs. In Russian.

Experimental evaluation of the fatigue characteristics of gasturbine blades after 4000 hours of running in operation. The regression equations of the fatigue curves are calculated, and the load-bearing surface of the blades after running in is plotted. It is established that under standard conditions of operation the blade lifetime after 10,000,000 cycles decreases by an average of 13 to 15%.

A74-18088 # A study of the combined vibrations of the disk-blade system of a turboprop engine turbine wheel (Issledovanie sownestnykh kolebanii sistemy disk-lopatki rabochego kolesa turbiny TVD). A. K. Panteleev, L. N. Rzhavin, N. I. Glushchenko, V. I. Konovalov, and S. S. Tripol'skii. *Problemy Prochnosti*, vol. 5, Nov. 1973. p. 78-81. In Bussian.

Study of the nature and mode of the blade and disk vibrations in the wheel of the third stage of a turboprop engine turbine. It is shown that the high stresses in the blades are caused by critical rotations of the wheel in the presence of mode vibrations with five nodal diameters. It is further shown that these vibrations can be eliminated by making appropriate changes in the elements of the system. A correlation is established between the critical rpm and the mean frequency in the case of a set of blades vibrating in the axial mode; on the basis of this correlation a control over the mean frequency of this set of blades during production is introduced.

A.B.K.

A74-18090 # Suitability of using titanium pipelines in the hydraulic systems of turbine engines (O tselesoobraznosti primeneniia titanovykh truboprovodov v gidravlicheskikh sistemakh gazoturbinnykh dvigatelei). L. A. Vanetsov and A. F. Zhirnov. *Problemy Prochnosti*, vol. 5, Nov. 1973, p. 85, 86, In Russian.

A74-18097 Vortex cases - At a turbulent crossroads. P. Silverman (Speiser, Krause and Madole, Washington, D.C.). Journal of Air Law and Commerce, vol. 39, Summer 1973, p. 325-342. 74

Discussion of some of the legal aspects of the problem of wake turbulence, a phenomenon to which a substantial number of air crashes has been attributed in recent years. The duty of air traffic controllers to warn of possible wake turbulence and the nature of this warning are examined. A number of court cases is reviewed to show how the courts look at wake turbulence, and some controversial cases are analyzed. During 1968-1970, more than \$3,000,000 have been paid by the United States Government in indemnities where air traffic controllers were judged to have been negligent in helping prevent air crashes that had been caused by wake turbulence. It is felt that wake turbulence accidents cannot be expected to cease to happen, but the trend against the Government may ease sufficiently to permit a greater sharing of responsibility by pillots, the flying schools, and air taxi operators that employ them.

M.V.E.

A74-18098 Government responsibility for damages in airplane crash cases when weather is a factor. J. D. Jamail. *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 343-351, 23 refs.

The legal problems are considered that arise when an airplane crashes because of inadequate weather information. The analysis includes a discussion of the waiver of sovereign immunity in the Federal Torts Claim Act and the exceptions to that waiver, as well as the duties of government employees and the preparation for trial of weather-related cases.

M.V.E.

A74-18099 An innovative approach to airport planning. H. L. Newman (FAA, Fort Worth, Tex.). Journal of Air Law and Commerce, vol. 39, Summer 1973, p. 353-359.

The spirit of foresight and cooperation is described that made the realization of the mammoth Dallas-Fort Worth Airport Project possible. The airport was officially dedicated in September 1973. The main considerations that went into the planning of this airport and the experiences of the people who worked on this project are reviewed.

M.V.E.

A74-18100 Skyjacking and airport security, R. S. Maurer (Delta Air Lines, Inc., Atlanta, Ga.). *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 361-380. 26 refs.

The various factors are examined that are believed to have brought about the noticeable decline of airplane hijackings in recent years. The methods developed by airlines and the faderal government for meeting the hijacking problem are reviewed, and the constitutional and practical consequences of these methods are discussed.

M.V.E.

A74-18101 The aftermath of a hijacking - Passenger claims and insurance, G. N. Tompkins, Jr. (Notre Dame, University, Notre Dame, Ind.). *Journal of Air Law and Commerce*, vol. 39, Summer 1973, p. 381-398, 69 refs.

A74-18139 # Decoupling of a class of nonlinear systems and its application to an aircraft control problem. S. J. Asseo (Calspan Corp., Buffalo, N.Y.). *Journal of Aircraft*, vol. 10, Dec. 1973, p. 739-747, 11 refs, Contract No. F33615-70-C-1647.

The necessary and sufficient condition for decoupling a non-linear system with state feedback is obtained. It is shown that when this condition is satisfied there exists a control law which makes each output variable of the dynamical system independently controllable with a separate input. The theory is then applied to an aircraft control problem where the implication of the theoretical results is discussed. The objective of the aircraft control problem is to decouple the vertical and the horizontal path angles of the flight trajectory relative to earth-fixed axes. The aircraft equations are simplified by postulating a rudder control law which maintains zero sideslip velocity in flight. The control laws for the elevator and aileron which decouple the simplified aircraft model are obtained. The control system is then evaluated in a simulation study to show that it indeed decouples the flight path angles.

(Author)

A74-18140 * # An unsteady wake model for a hingeless rotor. S. T. Crews, K. H. Hohenemser (Washington University, St. Louis, Mo.), and R. A. Ormiston (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). Journal of Aircraft, vol. 10, Dec. 1973, p. 758-760. 7 refs. Contract No. NAS2-4151.

A simple nonsteady wake model derived from the unsteady moment of the momentum equation for zero advance ratio is correlated with cyclic pitch frequency response tests conducted with a small hingeless rotor model. Two and three or more bladed rotor analyses are presented.

M.V.E.

A74-18141 # Dynamics of slung bodies utilizing a rotating wheel for stability. E. C. Micale and C. Poli (Massachusetts, University, Amherst, Mass.). Journal of Aircraft, vol. 10, Dec. 1973, p. 760-763. 8 refs. Army-supported research.

Investigation of the use of a reaction wheel to aid in the stabilization of slung bodies during airborne load towing. Both the longitudinal and lateral degrees of freedom are considered. While not completely satisfactory, the addition of a reaction wheel is found to have a very favorable effect on lateral stability.

M.V.E.

A74-18142 # On the fuel optimality of cruise. J. L. Speyer. Journal of Aircraft, vol. 10, Dec. 1973, p. 763-765. 8 refs. For the minimum fuel-fixed range with time either free or specified, the cruise condition based upon Schultz and Zagalsky's (1972) model of aircraft dynamics is shown not to be a minimizing singular arc by application of the generalized Legendre-Clebsch condition for vector control. This is seen to be consistent with the results for the energy-state approximation for which intermediate values of thrust are not minimizing.

M.V.E.

A74-18143 # Inviscid wake-airfoil interaction on multielement high lift systems. A. Moser and C. A. Shollenberger (McDonnell Douglas Research Laboratories, St. Louis, Mo.). *Journal* of Aircraft, vol. 10, Dec. 1973, p. 765-767. 5 refs.

A linearized method is presented for estimating the inviscid wake effect on the flap surface pressure or lift when, in a multielement airfoil system, a wake shed by the main airfoil flows over the flap elements. An explanation of the effect is attempted, and the method application results are compared with 'exact' numerical calculations using a recently developed singularity method.

M.V.E.

A74-18176 Fixed wing aircraft (Starrflügelflugzeuge). R. Riccius (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1441-1445. 31 refs. In German.

New developments in the field of subsonic aircraft are considered, giving attention to the VFW614, the airbus A300B, the B747SP, the B747SR, and STOL aircraft. Changes in the design of the supersonic TU144 are briefly reported along with questions concerning the operational status of the Concorde. It is pointed out that in the area of general aviation aircraft for business trips become more and more similar to the large airliners as far as performance and the convenience of traveling is concerned, Advances in the field of military aircraft are also reviewed.

G.R.

A74-18177 Rotary-wing aircraft (Drehflügel-Flugzeuge). G. Reichert (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn; Darmstadt, Technische Hochschule, Darmstadt, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1446-1448. 48 refs. In German.

A heavy lift helicopter which is capable to carry a payload of about 25 metric tons is being developed. New technologies of rotor design are discussed together with advances in bearing construction, the military utility tactical transport aircraft system program, the advanced attack helicopter, and the light observation helicopter. A number of research programs are concerned with the development of novel rotor systems.

G.R.

A74-18178 Vertical take-off and landing aircraft (Vertikal startende und landende Flugzeuge). S. Harmsen (Berlin, Technische Universität, Berlin, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1449-1451, 20 refs. In German.

Studies were conducted concerning the suitability of an employment of VTOL aircraft for solving transportation problems in West Germany, giving attention to the operation of helicopters which utilize different types of propulsion systems. Questions of the experimental testing of helicopter designs are considered together with problems of flight simulation, the noise produced by the propulsion system, operational aspects, aerodynamics, and recirculation effects.

G.R.

A74-18179 Propulsion system installations (Triebwerks-anlagen). O. Łutz (Braunschweig, Technische Universität, Braunschweig, West Germany) and W. Alvermann (Deutsche Forschungs- und Versuchsanstallt für Luft- und Raumfahrt, Institut für Antriebssysteme, Braunschweig, West Germany). VDI-2, vol. 11.5, no. 18, Dec. 1973, p. 1451-1456. 41 refs. In German.

The state of development of propulsion systems is examined, giving attention to the number of units needed, studies conducted to improve subsonic aircraft characteristics, advances concerning STOL aircraft, supersonic aircraft, and engines for the propulsion of large aircraft carrying 700 passengers. Possibilities for reducing the noise in the case of jet engines are considered together with approaches for noise attenuation in the area of the piston engines of general aviation, and ways to increase the thrust during take-off. New methods for increasing the performance of jet turbines are also discussed, taking into account subsonic and supersonic aircraft. G.R.

A74-18180 Aviation fuels and lubricants (Flugkraftstoffe und Flugschmierstoffe). G. Spengler (München, Technische Universität; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe; Landesgewerbeanstalt, Bayern, Prüfamt für Brenn-, Kraft- und Schmierstoffe, Munich, West Germany), E. Jantzen, and J. Kern (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe, Munich, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1457-1459, 52 refs. In German.

It is pointed out that in the case of the fuel required for supersonic aircraft the lubricating properties of the fuel itself are insufficient. The needed lubricating characteristics of the fuel have, therefore, to be provided by suitable additives. Approaches for reducing the air pollution produced by aircraft are discussed together with developments regarding fuels for missiles operating at conventional and hypersonic velocities. The use of dry lubricating agents, such as molybdenum disulfide, is considered in connection with a discussion of aviation lubricants.

G.R.

A74-18181 Flight control (Flugregelung). F. Leiss, G. Schweizer, and H. Seefmann (Dornier-System GmbH, Friedrichshafen, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1459-1461, 37 refs. In German.

The employment of computers for the guidance and control of aerospace vehicles is considered. It is pointed out that the design of efficient programming languages is a crucial factor for an economic control system. Stabilization and flight control systems are discussed together with questions regarding the instrumentation needed and details concerning the navigation systems required.

G.R.

A74-18182 Air traffic control (Flugsicherung). O. Heer (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1462-1465. 18 refs. In German.

For the last two years studies concerned with the air traffic control system of the future have been conducted in West Germany, giving attention to the time after 1980. Questions of long-term planning are discussed together with new developments in the sector of air traffic control and the improvement of existing procedures and installations. Problems of frequency distribution are considered along with traffic flow questions, navigational systems, instrumental landing systems, radio equipment, and radar installations.

G.R.

A74-18190 Structural materials of aeronautics and astronautics (Strukturwerkstoffe der Luft- und Raumfahrt). E. Loechelt (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany). VDI-Z, vol. 115, no. 18, Dec. 1973, p. 1495-1498. 46 refs. In German.

Components made of steel are used in an aircraft whenever the material is subjected to high stress concentrations. Under certain conditions savings in weight can be obtained by replacing the steel alloys with titanium alloys. Suitable steel and titanium alloys are discussed, giving attention also to new developments in the areas of powder metallurgy, titanium precision forgings, and titanium castings. New advances in the fields of aluminum alloys are considered

together with magnesium alloys, fiber-reinforced composite materials, and the state of development of beryllium technology.

GR

A74-1826t The German law for protection against the noise of aircraft (La loi allemande pour la protection contre le bruit des aéronefs). R. Goy (Rouen, Université, Rouen, France). Revue Générale de l'Air et de l'Espace, vol. 36, no. 3, 1973, p. 267-282. In French.

The law for protection against aircraft noise was one of the first dealing with the subject, and is exemplary for the conditions of its adoption and for its content, because it attacked the problems and defined solutions in a way very rich in information for other countries. The law originated in various discussions, and was further developed in parliamentary debates. The debates dealt with passive and active protection against noise. The text of the law is given in an appendix.

A74-18271 # Control of an elastic aircraft (Ob upraylenii uprugim samoletom). T. P. Grigor'eva. Avtomatika i Telemekhanika, Nov. 1973, p. 5-10. 5 refs. In Russian.

Study of large-dimension systems, and development of a method for synthesizing a control law based on the combined measurement of the coordinates of both aircraft motion and elastic airframe oscillations. A numerical example is presented for illustrating the method.

M V F

A74-18288 # Experimental study of the internal noise in injector driven wind tunnels (Etude experimentale du bruit interne dans les souffleries a induction). V. Schmitt (ONERA, Châtillonsous-Bagneux, Hauts-de-Seine, France). (Supersonic Tunnel Association, Meeting, 40th, Bedford, England, Sept. 24-26, 1973.) La Recherche Aérospatiale, Nov.-Dec. 1973, p. 321-324. In French. (Translation).

The strong emission of acoustic perturbations by the supersonic injector, as the driving element of an injector-driven wind tunnel, required basic studies concerning its positioning in the circuit, its design and its mode of operation, so as not to jeopardize the quality of the flow and, consequently, the validity of the tests. The solutions put forward at the present stage of studies are presented, based on the experience acquired in a pilot wind tunnel which offers the possibility of a detailed study of the injector as regards its performance and the flow quality. A number of particulars emerge from the initial results concerning the internal noise of this wind tunnel.

A74-18289 # Numerical investigation of vortex sheets issuing from a separation line near the leading edge (Etude numérique de nappes tourbillonnaires issue d'une ligne de décollement près du bord d'attaquel. C. Rehbach (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (EUROMECH, Colloque sur les Tourbillons Concentrés, 41st, Norwich, England, Sept. 18-21, 1973.) La Recherche Aérospatiale, Nov. Dec. 1973, p. 325-330. 15 refs. In French. (Translation).

Observation shows that, even for small incidences, the flow around slender delta wings separates along a line near the leading edge, forming a vortex sheet which rolls up into a pair of spiral vortices. A theoretical treatment of this problem is possible for this simple form of wing and has been carried out within the limits of such approximations as slender-body theory and/or conical flow. However, the phenomenon of building up of vortex sheets on the leading edge of lifting surfaces is encountered for more general geometric configurations for which an analytic treatment is out of the question. For these configurations, an iterative calculation method is proposed which is based on the substitution of the vortex sheet representing the wing and its trailing sheet by a network of concentrated line vortices. All though the proposed method might be used for wings of arbitrary shape, the results presented are limited to

those of plane delta wings. They are compared with results obtained by purely analytic methods, and with experiments performed in a water tunnel. (Author)

A74-18291 # Calculation of the dynamic characteristics of a helicopter structure by the method of branch modes (Calcul des caracteristiques dynamiques d'une structure d'hélicoptère par la méthode des modes partiels). C. T. Tran, R. Dat (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), and W. Twomey. La Recherche Aérospatiale, Nov. Dec. 1973, p. 337-354. 5 refs. In French. Research supported by the Société Nationale Industrielle Aérospatiale.

A74-18296 Automatic flight controls in fixed wing aircraft - The first 100 years. R. W. Howard (Marconi-Elliott Avionic Systems, Ltd., Rochester, Kent, England). Aeronautical Journal, vol. 77. Nov. 1973, p. 533-562, 58 refs.

The evolution of the systems involved in automatic flight controls is reviewed, concentrating mainly on the period from the beginning up to the end of World War II. Early history is first reviewed, followed by discussion of developments after Kitty Hawk. The concept of design for high stability with limited controllability had been shown to be undesirable. The work carried out during the first world war, the 1920s, and the 1930s is examined. British, American, and German studies carried out in World War II are treated. The first post-war civil and military aircraft were fitted with equipments which were fimited developments of wartime devices, and particulars of developments are given. The post-war autopilot is described, and attention is given to analog simulation, the solid state era, high pressure hydraulic systems, automatic landing, redundancy, microcircuits, and digital computing. Brief particulars of the Concorde automatic flight control system are given.

A74-18297 Random vibration with non-linear damping. C. L. Kirk (Cranfield Institute of Technology, Cranfield, Beds., England). Aeronautical Journal, vol. 77, Nov. 1973, p. 563-569. 6

The random vibration of linearly elastic, lumped-mass systems containing nonlinear damping to ideal stationary Gaussian white noise excitation is studied. It is shown experimentally that the hysteretic restoring force in a built-up beam reduces the rms acceleration by a maximum of about 13% for q = 12.5 lbf/in. For lower or higher values of q the response is essentially the same as that of the solid beam. The effect of nonlinearity is to produce a non-Gaussian response similar to that obtained with (velocity)2 damping. The experiments confirm qualitatively the rms response characteristics predicted theoretically by Caughey (1960). F.R.L.

A74-18299 Helicopter modelling /18th Henson and Stringfellow Lecture/. R. A. Ormiston (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). Aeronautical Journal, vol. 77, Nov. 1973, p. 579-591. 23 refs.

Helicopter models provide a comparatively simple, inexpensive, and safe alternative to full scale flight testing. They are also invaluable for studying problems that are too complex for mathematical analysis and for exploring flight conditions that may be especially hazardous. The inherent versatility of small-scale helicopter models stems mainly from the capability for testing special configurations and making trial and error modifications that would be impossible or impractical with large scale models or flight test aircraft. Three general categories of helicopter modeling are discussed. These are exploratory models, which are used for investigating radically new concepts or ideas; development models, which are used in direct support of the design and development of new helicopters; and research models, which are necessary to advance the fundamental knowledge on which helicopter technology is based.

A74-18596 The Eole balloons and air safety (Les ballons Eole et la sécurité aérienne). J. Muller (Centre National d'Etudes Spatiales, Brétigny-sur-Orge, Essonne, France). L'Aéronautique et l'Astronautique, no. 42, 1973, p. 3-14. In French.

The 500 balloons of the Eole space program have fulfilled their meteorological mission. They flew at a constant altitude of 36,000 feet in the Southern Hemisphere during several months. This flight altitude is also that of long distance jetliners and an eventual collision was possible. During four years, the CNES undertook a technical program, in order to study and fabricate balloon payloads, non-hazardous to air traffic. The tests were conducted on the two very sensitive areas of a plane; the windshield of the cockpit and the jet engines. By simulating collisions in the ground facilities, guide lines were clearly defined for manufacturing components and complete tests were performed on the flight models to be certain that the payload was not dangerous for the aircrafts. (Author)

A74-18597 Theory and practice of avionics reliability (Théorie et pratique de la fiabilité des équipements). M. M. Ravier (Compagnie Nationale Air France, Paris, France). L'Aéronautique et l'Astronautique, no. 42, 1973, p. 18-24. In French.

Some of the theoretical and practical aspects of the maintenance and reliability of avionics systems are reviewed. Discussed topics include the actuarial approach to failure expectancy as a function of age, acceptable reliability criteria, service life extension and reliability, maintenance routines, and manufacturer-airline liaison. M.V.E.

A74-18598 Importance of the means of engine condition surveillance (Importance des moyens de surveillance d'état des moteurs). M. F. Fry (Compagnie Nationale Air France, Paris, France). L'Aéronautique et l'Astronautique, no. 42, 1973, p. 25-32. In French.

Review of the nature and efficiency of the various techniques used for keeping the condition of aircraft engines under proper surveillance, and assessment of the relative costs of these techniques. The techniques considered include performance monitoring, inspection by boroscope, detection by Foucault currents, gamma-ray inspection, and spectroscopic and physico-chemical analyses of the oil used in the lubrication of the engines.

M.V.E.

A74-18599 Aircraft and systems reliability (Fiabilité avion et systèmes). M. R. Cypkin (Compagnie Nationale Air France, Paris, France). L'Aéronautique et l'Astronautique, no. 42, 1973, p. 33-37. In French.

The application of individual systems reliability analysis and enhancement techniques to the very elaborate overall systems complex that modern aircraft represent is discussed. Special attention is given to aircraft overhaul and maintenance routines and the interrelation of various reliability criteria.

M.V.E.

A74-18603 Supersonic compressor test facility (Banc d'essai de compresseur supersonique). F. Charron, G. Janssens, and J. Paulon. L'Aéronautique et l'Astronautique, no. 42, 1973, p. 79-88. 11 refs. In French.

Description of a 1500-kW supersonic compressor test facility. This bench of closed-circuit type, uses freon 114 as the active gas, and operates at subatmospheric pressure. The related control and monitoring circuits of this facility are thus rather complex. The aerodynamic study of the compressor includes, as well as overall measurements, detailed explorations of the flow in various locations, as shown in a few examples. (Author)

A74-18632 # A method of calculating the flow around a wing of arbitrary planform, positioned on a cylindrical body (Metod rascheta obtekanila kryla proizvol'noi formy v plane, raspolozhennogo na tsilindricheskom tele). V. A. Graivoronskii and M. A. Koval'. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 3-10. In Russian.

Analysis of the nonseparated steady flow of a perfect fluid around a low-aspect-ratio wing on a relatively long cylindrical body. The wing is modeled by a previously proposed vortex system that can be used in flow calculations for a wide range of angles of attack. The cylinder is modeled with a system obtained by mapping segments of free wing vortices.

T.M.

A74-18635 # Evaluation of the influence of errors in specifying boundary conditions on the accuracy of the determination of temperature fields in infinite cylinders (Otsenka vilianiia pogreshnostei pri zadanii granichnykh uslovii na tochnost' opredeleniia temperaturnykh polei beskonechnykh tsilindrov). E. E. Prokhach. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 19-25. In Bussian.

A74-18638 # Evaluation of the operations contained in algorithms carried out by digital controller computers (Otsenka sostava operatsii algoritmov realizuemykh na tsifrovykh upravliaiushchikh mashinakh). V. A. Popov. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 34-39. In Russian.

A74-18641 # Some current problems and prospects for development of rotary-wing aircraft (Nekotorye voprosy sostoianiia i perspektiv razvitiia legkikh vintokrylykh letatel'nykh apparatov), B. I. Mysov and V. N. Revinov. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 47-52. In Russian,

A74-18642 # Analytical design of optimal monolithic panels (Analiticheskoe proektirovanie optimal nykh monolitnykh panelei). F. G. lasinskii, Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 52-61. 7 refs. In Russian.

Description of an approximate analytical method of calculating the geometrical parameters of optimal monolithic panels subject to compressive loads at normal and elevated temperatures. Geometrical dimensions are expressed analytically in terms of load levels, mechanical properties of the panel material, and size ratios. The fact that no auxiliary graphs are required permits the use of the method as a computer aided design procedure.

T.M.

A74-18645 # An algorithm for rational selection of the parameters of nonlinearly deforming thin-walled framework elements (Ob odnom algoritme ratsional'nogo vybora parametrov nelineino deformiruemukh tonkostennykh karkasirovannykh sterzhnei). V. M. Riabchenko, V. G. Toporov, and V. E. Lukhanin. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 77-85. B refs. In Russian.

A74-18648 # Experimental study of metal-plastic couplings in tension (Eksperimental'noe issledovanie metalloplastikovykh sochlenenii pri rastiazhenii). V. E. Gaidachuk, A. F. Pil'nik, and I. N. Tsybul'nik, Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 31, 1973, p. 100-105. In Russian.

A74-18654 # The new Advanced Airborne Command Post.
D. E. Graves (Boeing Aerospace Co., Seattle, Wash.). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-240. 7 p. Members, \$1.50; nonmembers. \$2.00.

The need, functional and physical descriptions, and equipment configuration for the new Advanced Airborne Command Post (AABNCP) are presented. Based on the commercial Boeing 747 airplane and equipped with modern command, control, and communications equipment that will assure real-time, survivable, strategic force management, the AABNCP can provide the Commander-in-Chief with real-time information regarding the availability of

strategic force assets during battle to assure full utilization of surviving retaliatory weapons.

M.V.E.

A74-18655 # Airborne warning and control system /AWACS/. R. G. Cross, Jr. (USAF, Washington, D.C.). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-241. 5 p. Members. \$1.50: nonmembers. \$2.00.

The E-3A AWACS, Airborne Warning and Control System, is being developed by the United States Air Force to furnish an improved capability for management of air operations during future potential crises. The most distinguishing feature of AWACS is its advanced surveillance radar, which is integrated with suitable control and computational equipment on a rapidly deployable jet platform. Operating from a general purpose aircraft pool, AWACS will constitute a national resource to furnish necessary support for world-wide tactical or strategic defensive contingencies, enhancing deterrence and increasing effectiveness of our military forces.

(Author)

A74-18664 # Structural analysis of light aircraft using NASTRAN. C. Eaton and A. Dobbins (Louisiana Tech University, Ruston, La.). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-257. 3 p. Members, \$1.50; nonmembers, \$2.00.

A three-dimensional structural analysis was performed on the Baby Ace aircraft using the general structural program called NASTRAN. The model consisted of 195 grid points and 352 beam members. The load distribution arising from aerodynamic forces was applied consistent with Federal Aviation Administration Utility Category guidelines of 4.4 g loading. Two loading cases of a high and low angle of attack were investigated. An inertial relief method was used which consistently distributed inertial loads throughout the aircraft in proportion to the mass distribution. The masses of both structural and nonstructural components were included. It is concluded that the cost of the analysis is prohibitive for most homebuilt designs. (Author)

A74-18665 # A sailplane wing constructed of foam core and polyester fiberglass skin. R. D. Kriz. American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-258. 6 p. 5 refs. Members, \$1,50; nonmembers, \$2,00.

The results from a stress analysis of a thin skin, foam core, high aspect ratio wing indicate a possible method of constructing sailplane wings. The analysis includes an approximation of the maximum core and skin shear stress, a computer program to evaluate the stress distribution and displacements of a thin walled unsymmetrical tapered cylinder and the accountability of creep. (Author)

A74-18666 # Wind tunnel dynamic analysis of an oscillating airfoil. R. J. Silcox and W. J. Szwarc (Notre Dame, University, Notre Dame, Ind.). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-269. 10 p. 6 refs. Members, \$1.50; nonmembers, \$2,00.

Flow visualization of the stream field of an oscillating airfoil in linear flow is presented. The sequence of events leading up to and through dynamic stall of NACA airfoil 0012 is demonstrated. Emphasis is placed on the laminar separation and subsequent reattachment of the flow over the leading edge bubble and the resulting vortex shed from the leading edge. The delay of stall in the dynamic model is shown and discussed. Possible physical models are presented and compared with experimental results. (Author)

A74-18669 # Future air traffic control - Ground, cockpit, or space. D. R. Israel (FAA, Office of Systems Engineering Management, Washington, D.C.). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-262. 5 p. Members, \$1.50; nonmembers, \$2.00.

The possibilities for transferring existing functions of our largely ground-based air traffic control system to aircraft cockpits or to space platforms are considered against an anticipated doubling of traffic activity every 10-15 years and major growth in the general aviation category of flying. The transfer of functions to the cockpit does not promise to produce economy or efficiency, and hence will be limited. Early use of aeronautical satellite relays for voice communications and surveillance is planned for oceanic air traffic control. The cost of avionics is the major deterrent to the use of satellites for any traffic control purposes over the United States.

(Author)

A74-18674 # Influence of boundary layer blowing on the low-speed aerodynamic performance of a 45 degree swept-wing airplane. J. D. Sorenson (USAF, Hill AFB, Utah). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-269. 13 p. 18 refs. Members, \$1.50; nonmembers, \$2.00.

This paper presents the results of a research and flight test evaluation of a 45 degree swept-wing jet airplane with and without blowing boundary layer control (BLC) being applied to the upper surface of the wing airfoil. The test vehicle used during this study was an F-4 jet airplane which employs a leading and trailing edge blowing-type BLC system. Data presented in this paper demonstrate that a significant improvement in the landing performance characteristics of a high speed swept-wing airplane can be obtained by injecting a high velocity air mass (blowing) into the primary layer airstream. Results obtained during this study show that the approach speed, sink rate, landing speed, and landing roll distance of a particular airplane are significantly improved when a blowing-type boundary layer control system is designed into the airplane. (Author)

A74-18675 * # A direct method for calculating flutter speeds.

D. P. Beres (Ohio State University, Columbus, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974; Paper 74-27.

B p. Members, \$1.50; nonmembers, \$2.00. Grant No. NGL-36-008-109.

The basic objective of this work is to provide a direct, and simple means for calculating classical flutter. The analysis makes no use of free vibration modes, although the method is readily adaptable to a modal type approach. Only subsonic aerodynamics are considered; however, the method applies to any speed regime. The problems of following modes and modal coupling are completely avoided. The simplicity and accuracy of the direct solution is stressed. The analysis is applicable to both straight and swept wings although only straight wings, uniform as well as nonuniform, are presented. (Author)

A74-18681 # Calculation of the aerodynamic characteristics of a wing system moving at subsonic speed near land or smooth water surface (Raschet aerodinamicheskikh kharakteristik sistemy kryl'ev, dvizhushcheisia s dozvukovoi skorost'iu vblizi zemli ili gladkoi vodnoi poverkhnosti). S. D. Ermolenko and V. G. Khrapovitskii. Samoletostroenië i Tekhnika Vozdushnogo Flota, no. 32, 1973, p. 3-15. 6 refs. In Russian.

A74-18682 # Some specific characteristics of small gas turbines and the modeling problems of their wind tunnel testing (Nekotovye osobennosti malogabaritnykh gazovykh turbin i voprosy modelirovaniia pri produvkakh ikh vozdukhom). V. V. Il'inskii and E. A. Skvorchevskii. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 32, 1973, p. 16-19. In Russian.

A74-18684 # Heat transfer investigation in a high-temperature gas flow spreading over a plane surface (K issledovanilu teploobmena pri natekanii vysokotemperaturnogo gazovogo potoka na ploskuiu poverkhnost). I. P. Goldaev, V. Iu. Latka, A. P. Pershin, and V. P. Sabadash. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 32, 1973, p. 23-25. In Russian.

A74-18686 # A film thermocouple with a platinum electrode for thermometry of gas turbine engine blades (Plenochnaia termopara s platinovym termoelektrodom dlia termometrii rabochikh lopatok gazoturbinnykh dvigatelei). A. la. Anikin, L. S. Grigor'ev, and D. F. Simbirskii. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 32, 1973, p. 31-36, 7 refs. In Russian.

A74-18694 # Determination of the basic parameters of light helicopters on the basis of the treatment and analysis of statistical data (Opredelenie osnovnykh parametrov legkikh vertoletov na osnovanii obrabotki i analiza statisticheskikh materialov). V. N. Revinov and B. I. Mysov. Samoletostroenie i Tekhnika Vozdushnogo Flota. no. 32, 1973. p. 80-86. In Russian.

Development of a method of carrying out a preliminary choice of parameters pertaining to very light helicopters with flight weights up to 900 kg. A method of determining the basic flight-engineering characteristics of a light helicopter is proposed which is based on a scheme of mutual correlation of parameters involving the use of functional dependences of the various parameters on the flight weight and the power plant capacity. The mutual correlation scheme is constructed in such a way that a given parameter depends on several variables, thus eliminating any randomness in determining the final result, which is expressed as the arithmetic mean of several determination variants.

A.B.K.

A74-18697 # Experimental investigation of glass-plastic and metal-plastic joints under shear (Eksperimental noe issledovanie stekloplastikovykh i metalloplastikovykh soedinenii pri sdvige). V. E. Gaidachuk, A. F. Pil'nik, and I. N. Tsybul'nik. Samoletostroenie i Tekhnika Vozdushnogo Flota, no. 32, 1973, p. 102-107. In Russian.

A74-18722 # Noise from nonuniform turbulent flows. C. H. Berman (Boeing Commercial Airplane Co., Seattle, Wash.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-2. 11 p. 26 refs. Members, \$1.50; nonmembers, \$2.00.

The effects of a nonuniform mean flow on turbulence noise generation and propagation are treated analytically. A special form of an equation studied by Lilley is applied to a parallel flow model possessing arbitrary mean velocity and temperature profiles. Solutions of the resultant ordinary differential equation show that inviscid attenuation of sound occurs at very high frequencies, while a boost in sound level is present at very low frequencies. A new interpretation of shear and self noise generation terms is presented. The applicability of these results to jet noise prediction is discussed. (Author)

A74-18723 # Jet noise modeling - Experimental study and models for the noise and turbulence fields. L. F. Moon and S. W. Zelazny (Bell Aerospace Co., Buffalo, N.Y.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-3. 11 p. 33 refs. Members, \$1.50; nonmembers, \$2.00. Research sponsored by the Bell Aerospace Co.; Contract No. F44620-70-C-0116.

Detailed turbulence profiles were measured at 28 axial locations extending from the nozzle exit to twelve nozzle diameters downstream for a circular jet exhausting into an ambient environment. Measurements include mean velocity, turbulence intensity, shear stress as well as sound intensity, spectral distribution and directivity. A noise model was developed which accurately predict sound amplitude, spectral distribution and directivity pattern in terms of

self and shear noise components. A turbulence model was also developed which accurately predicted mean velocity, turbulence intensity, and shear stress in subsonic and supersonic axisymmetric jets with predictions starting in the potential core. Turbulence and noise models were computationally coupled and the sensitivity of noise predictions to inaccuracies in the predicted turbulence field studied. It is shown that errors of only 20% in predicted peak turbulence intensity level in the core region results in up to a 5-db difference in the predicted overall sound pressure level. (Author)

A74-18732 # Erosion prediction in turbomachinery due to environmental solid particles. G. Grant (Northrop Corp., Beverly Hills, Calif.) and W. Tabakoff (Cincinnati, University, Cincinnati, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-16. 17 p. 14 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. DA-ARO(DI-124-G154.

The erosion resulting from solid particles injested into rotating machinery is predicted using a Monte Carlo simulation of the physical process. This simulation takes into account the aerodynamic drag on the contaminant particles, the rebound dynamics of the particles impacting the solid blades or channel walls and the material removal process. The computerized model is used to 'predict the quantity of material removed from the stationary and rotating blades of a turbomachine as well as the location of the erosion of the blades. This model is verified by testing a specially designed one and one-half stage compressor and measuring the erosion. (Author)

A74-18736 # Two numerical methods to solve realistic air-to-air combat differential games. A. L. Leatham (U.S. Air Force Academy, Colorado Springs, Colo.) and U. H. D. Linch (USAF, Space and Missile Systems Organization, Los Angeles Air Force Station, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Pager 74-22. 9 p. 6 refs. Members, \$1.50; nonmembers, \$2.00.

A first-order gradient algorithm and a neighboring optimal algorithm are developed to solve the two-point boundary value problem associated with air-to-air combat differential games. Aerodynamic, structural, and engine constraints are properly incorporated into the mathematical description of the systems. To incorporate the constraints, angle of attack is used as the lift control below the corner speed and load factor is used above the corner speed. This artifice allows the use of constant-constraint boundaries which greatly simplify the problem formulation. Two numerical examples are solved to demonstrate the algorithms - a missile vs aircraft and an aircraft vs aircraft problem. Both algorithms are shown to be effective; however, the neighboring optimal method is limited to problems with no singular surfaces. (Author)

A74-18737 # Differential-turning optimality criteria. H. J. Kelley (Analytical Mechanics Associates, Inc., Jericho, N.Y.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jän. 30-Feb. 1, 1974, Paper 74-23. 6 p. 8 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. N00014-73-C-0328.

Circling encounters between aircraft modelled in energy approximation are studied in a differential game setting. Capture is defined in terms of turn-angle and a derived altitude-match requirement. Two optimality criteria are obtained; one a necessary condition for capture of an optimally evading opponent in a prolonged turning chase, the second a sufficient condition guaranteeing capture. Since there is not an unduly large gap between these conditions, they appear of interest as design criteria providing measures of overall turn-performance superiority of one aircraft design over another.

(Author)

A74-18738 Application of damage tolerance technology to advanced metallic fighter wing structure, L. L. Jeans and R. L. La Rose (Northrop Corp., Aircraft Div., Hawthorne, Calif.), American

Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-29. 10 p. 11 refs. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-72-C-1891. AF Project 486U.

Current Air Force damage tolerant criteria requirements were developed to ensure that proper emphasis is given in new aircraft structural systems to flaw initiated failure analysis. In this study damage tolerant criteria were analytically investigated in an indepth preliminary design environment on wing components representative of metallic materials and design concepts applicable to future fighter aircraft. Direct comparisons with static and fatigue strength considerations were made. Crack growth analysis was completed for the most critical structure using the Willenborg retardation model and appropriate material crack growth rate and toughness data. (Author)

A74-18745 * # Vortex age as a wake turbulence scaling parameter. J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.) and J. R. Marshall (U.S. Naval Weapons Laboratory, China Lake, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-36. 8 p. Members, \$1.50; nonmembers. \$2.00. Contract No. NAS1-10646-15.

Tests were conducted in the Virginia Tech Stability Wind Tunnel to determine the significance of vortex age as a scaling parameter in wake turbulence development and dissipation. Vortex structure was measured over a range of three angles of attack, three free-stream speeds, and seven downstream positions from 2 to 30 chordlengths using an NACA 0012 wing and a five hole yawhead probe. The resulting data indicates that vortex age is not a self-sufficient scaling parameter but a free-stream velocity influence also exists at higher angles of attack which cannot be explained in terms of Re or M. (Author)

A74-18747 # A method of calculating aircraft wake velocity profiles and comparison with full-scale experimental measurements. C. Donaldson, R. D. Sullivan (Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.), and R. S. Snedeker. American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-39. 12 p. 14 refs. Members, \$1.50; nonmembers, \$2.00. Research sponsored by the U.S. Department of Transportation, U.S. Air Force, and FAA.

A method is developed for the calculation of the initial inviscid form of rolled-up wake vortices behind a wing having arbitrary lift distribution. The method makes use of the Betz assumptions of conservation of wake vorticity and moments of vorticity. It is found that a simple relationship exists between the radial distribution of vorticity in the rolled-up wake and the spanwise lift distribution. Computed tangential velocity profiles for DC-7, DC-9, and C-141 aircraft are shown to compare favorably with profiles measured by the FAA during tower flyby tests of these aircraft in both flapped and unflapped configurations. (Author)

A74-18749 * # Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions. J. D. Holdeman (NASA, Lewis Research Center, Cleveland, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-41, 7 p. 5 refs. Members, \$1.50; nonmembers, \$2.00.

A method is presented for estimating the dispersion and dilution of jet aircraft exhaust from aircraft passage through times on the order of weeks thereafter. In the near wake of the aircraft, the solution is that for round turbulent jets in a parallel flow. More rapid dispersion due to atmospheric effects begins when the scale-dependent eddy viscosity becomes larger than the turbulent jet eddy viscosity. In the far wake region, the solution approaches that for scale-dependent dispersion from a point source moving with the aircraft. Calculations are presented for supersonic aircraft at high-altitude flight conditions.

(Author)

A74-18764 # Integral equation method for calculation of subsonic flow past airfoils in a ventilated wind tunnel - Comparison with NAE high Reynolds number measurements. M. Mokry (National Aeronautical Establishment, Ottawa, Canada). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-83. 16 p. 29 refs. Members. \$1,50: nonmembers. \$2,00.

A74-18765 * # Nonlinear aerodynamics of aircraft in highangle-of-attack maneuvers. M. Tobak and L. B. Schiff (NASA, Ames Research Center, Moffett Field, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-85. 11 p. 12 refs. Members, \$1.50; nonmembers, \$2.00.

A nonlinear aerodynamic moment system is formulated for arbitary motions of aircraft at high angles of attack. The total moment is shown to be compounded of the contributions from three simple motions. The basic motion is coning, where the nose of the aircraft describes a circle around the velocity vector, while the remaining motions are oscillatory perturbations carried out in the presence of coning. A re-examination of the assumptions underlying the formulation enables a characterization of aerodynamic phenomena whose effects can and cannot be treated within the scope of the formulation. Recommendations are made as to the most appropriate types of wind-tunnel tests that could be undertaken in fulfillment of the formulation's requirements. (Author)

A74-18768 * # Sonic inlet noise attenuation and performance with a J-85 turbojet engine as a noise source. H. W. Groth (NASA. Lewis Research Center, Cleveland, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-91. 10 p. Members, \$1.50; nonmembers, \$2.00.

A74-18776 # Aerodynamic forces and moments on a slender body with a jet plume for angles of attack up to 180 degrees. E. L. Fleeman and R. C. Nelson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-110. 16 p. 25 refs. Members, \$1.50; nonmembers, \$2.00.

A74-18789 * # On repetitive flutter calculations in structural design. R. T. Haftka and E. C. Yates, Jr. (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-141. 12 p. 25 refs. Members, \$1.50; nonmembers, \$2.00.

The use of continually updated natural modes, called changing modes, is discussed together with the employment of fixed modes in the design process. 'No-derivatives' methods are considered. The flutter solution process is separated into parts which are mode dependent and parts which are mode independent. On the basis of this separation an attempt is made to identify the type of design problems which are suitable for the use of changing modes, and the type of problems which are more suitable for fixed modes. The use of derivative methods is also examined.

A74-18797 * # The jet engine design that can drastically reduce oxides of nitrogen. A. Ferri and A. Agnone (New York University, Bronx, N.Y.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-160. 10 p. Members, \$1.50; nonmembers, \$2.00. Grant No. NGR-33-016-131.

The problem is analyzed for the case of hydrogen fuel, taking into account supersonic and hypersonic vehicles using scramjet

engines. The combustion in scramjets occurs at very high velocity and in a short time. In scramjet combustor designs, two different criteria can be used to design the engine. The amount of NO formed in the diffusion flame depends substantially on the maximum temperature reached. Effects of changing the mode of combustion from a diffusion flame to a heat conduction flame are considered, giving attention to the amount of NO produced in an engine of a given design.

G.R.

A74-18798 "The refining of turbine fuels by modern hydrotreating. R. L. Richardson and B. Peralta (Union Oil Company of California, Brea, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-162. 5 p. Members, \$1.50; nonmembers, \$2.00.

This paper reviews the present status of technology for removing sulfur compounds and hydrogenating aromatics in jet fuels, often designated as turbine fuels. The newer technique of catalytic hydrotreating will be emphasized because of its effectiveness in removing sulfur as well as nitrogen compounds, its flexibility in refinery applications, and its ability to upgrade other fuel characteristics, such as smoke point, aromatics content and thermal stability. (Author)

A74-18807 * # Unsteady lift forces on highly cambered airfoils moving through a gust. H. Atassi (Notre Dame, University, Notre Dame, Ind.) and M. Goldstein (NASA, Lewis Research Center, Cleveland, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-88. 10 p. 11 refs. Members, \$1.50; nonmembers, \$2.00.

An unsteady airfoil theory in which the flow is linearized about the steady potential flow of the airfoil is presented. The theory is applied to an airfoil entering a gust. After transformation to the W-plane, the problem is formulated in terms of a Poisson's equation. The solutions are expanded in a Fourier-Bessel series. The theory is applied to a circular arc with arbitrary camber. Closed form expressions for the velocity and pressure on the surface of the airfoil are obtained. The unsteady aerodynamic forces are then calculated and shown to contain two terms. One in an explicit closed analytical form represents the contribution of the oncoming vortical disturbance, the other depends on a single quadrature and accounts for the effect of the wake. (Author)

A74-18808 * # A self-reorganizing digital flight control system for aircraft. R. C. Montgomery (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.) and A. K. Caglayan (NASA, Langley Research Center, Hampton; Virginia Polytechnic Institute and State University, Blacksburg, Va.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-21. 15 p. 7 refs. Members, \$1.50; nonmembers, \$2.00.

This paper presents a design method for digital self-reorganizing control systems which is optimally tolerant of failures in aircraft sensors. The functions of this system are accomplished with software instead of the popular and costly technique of hardware duplication. The theoretical development, based on M-ary hypothesis testing, results in a bank of M Kalman filters operating in parallel in the failure detection logic. A moving window of the innovations of each Kalman filter drives the detection logic to decide the failure state of the system. The detection logic also selects the optimal state estimate (for control logic) from the bank of Kalman filters. The design process is applied to the design of a self-reorganizing control system for a current configuration of the space shuttle orbiter at Mach 5 and 120,000 feet. The failure detection capabilities of the system are demonstrated using a real-time simulation of the system with noisy sensors. (Author)

A74-18812 * = Transonic flow about lifting wing-body combinations. R. W. Barnwell (NASA, Langley Research Center, Hampton,

Va.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-185, 16 p. 16 refs, Members, \$1.50; nonmembers, \$2.00.

Calculations for transonic flow about wing-body combinations at angles of attack of the order of the body thickness-to-length ratio are presented. These calculations show that lift can alter the flow drastically at near-sonic speeds in this angle-of-attack range so that the area rule must be modified. This effect of lift is explained from simple physical considerations. The computational procedure is based on slender-wing theory and a two-variable method of relaxation solution. A small perturbation analysis is used to show that this simple procedure is adequate for these transonic wing-body flow fields.

(Author)

A74-18813 # Trimmed drag and maximum flight efficiency of aft tail and canard configurations. S. E. Goldstein and C. P. Combs (Rockwell International Corp., Columbus, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-69. 13 p. 5 refs. Members, \$1,50; nonmembers, \$2.00.

An analytical method for estimating total trimmed drag polars of airplanes with two lifting surfaces is presented. Drag due to lift is developed as a function of the load carried by each surface, its aerodynamic characteristics, and the inclination of the aft surface lift due to downwash, Tail surfaces are sized consistent with stability and control constraints. Expressions for maximum trimmed cruise efficiency are also developed. Aft tails and canards are compared showing effects of changes in configurations, center of gravity, and stability requirements on trimmed drag in cruise and maneuvering flight. Regions of inherent advantage for each are indicated. A clear advantage is shown for canard configurations with wing tip-mounted vertical fins.

A74-18815 * # Ingestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere. J. N. Nielsen, S. S. Stahara, and J. P. Woolley (Nielsen Engineering and Research, Inc., Mountain View, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-42. 18 p. 15 refs. Members. \$1.50; nonmembers. \$2.00. Contract No. NAS2-7337.

Detailed analysis has been made of the ingestion and dispersion of engine exhaust products into the trailing-vortex system of a supersonic aircraft flying in the stratosphere. The rate of mixing between the supersonic jet and the coflowing supersonic stream was found to be an order of magnitude less than would be expected on the basis of subsonic eddy-viscosity results. Ingestion started at the end of the potential core, and all hot gas from the engine was ingested into the trailing vortex within two core lengths. The temperature rise in the wake of the supersonic aircraft was found to be much greater than that for a subsonic transport, since temperature rise varies directly as speed squared and inversely as aspect ratio. As a result, the final buoyancy phase started only ten seconds after leaving the trailing edge. Comparison between the buoyancy calculations for the supersonic case with nondimensionalized subsonic aircraft contrail data on wake spreading showed good agreement.

(Author)

A74-18831 # Isolated airfoil - TIP vortex interaction noise. R. W. Paterson, R. K. Amiet (United Aircraft Research Laboratories, East Hartford, Conn.), and C. L. Munch (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-194. 10 p. 8 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. DAHC04-72-C-0040.

An experimental investigation was conducted in a controlled turbulence-level, open-jet wind tunnel to define the noise characteristics associated with the interaction of a stationary tip vortex and a downstream stationary airfoil. This model test geometry simulated,

in its simplest form, the tip vortex-blade interaction which occurs on single-rotor helicopters during hover. For moderate to high lift test conditions, the vortex-airfoil interaction was found to cause local blade stall and an attendant increase in the blade far-field noise. These results indicate that this interaction may be an important source of helicopter broadband noise during hover. Cross-correlation measurements conducted amongst surface-mounted and far-field microphones demonstrated that the operative noise mechanism was 'trailing edge noise' arising from the interaction of stall generated eddies with the airfoil trailing edge. (Author)

A74-18832 # Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap. R. B. Oetting (Missouri, University, Rolla, Mo.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-191. 8 p. 13 refs. Members, \$1.50; nonmembers, \$2.00. Research supported by the Minna-James-Heineman-Stiftung.

A small model wind tunnel experiment was performed on a semispan wing with an upper-surface blown flap in order to determine the aerodynamic performance and acoustic characteristics at various wing-flap positions. The constant chord wing had an aspect ratio of 4.5 (2.25 for the semispan). Configurations with the upper-surface blown flap are compared with the corresponding nonblown flap configurations. Aerodynamic results indicate that upper-surface blowing increases the lift coefficient 33% at maximum lift for a flap deflection of 60 deg. In all cases tested, noise shielding by the wing was obtained. The noise level in the wake of the wing increases with flap deflection.

(Author)

A74-18833 # Methods for the design and analysis of jetflapped airfoils. N. D. Halsey (Douglas Aircraft Co., Long Beach, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-188. 12 p. 19 refs. Members, \$1.50; nonmembers, \$2.00. Research supported by the McDonnell Douglas Independent Research and Development Program.

Some recent developments in jet-flap airfoil theory are presented, including a nonlinear potential flow method for analyzing the flow about airfoils of given shape and a simple design method for determining the airfoil shapes required to produce specified velocity distributions. The nonlinear analysis method is believed to be superior to other similar methods in the suitability of its singularity distributions, the reliability of its iterative procedures, and its applicability to complex flow conditions. The design method, based on certain approximations which have been verified by the nonlinear analysis method, has been used to design airfoils having certain desirable characteristics. (Author)

A74-18834 # Thin-airfoil theory of an ejector-flapped wing section. H. W. Woolard (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-187. 12 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

A theoretical analysis of the aerodynamics of a thin ejector-flapped wing section (augmentor wing) is presented. The idealized external and internal (ejector) flow field and their approximate interfacing are treated. The linearized external flow-field analysis is an extension of Spence's method for jet-flapped airfoils. Summary curves of the section lift- and pitching-moment characteristics and their relation to the ejector characteristics are presented. Fourier coefficients are tabulated for use in calculating airfoil surface pressure distributions and other flow-field details. Comparisons are made with a related work by Y. Y. Chan. (Author)

A74-18835 * # Analysis of flow-reversal delay for a pitching airfoil. R. M. Scruggs, J. F. Nash, and R. E. Singleton (Scientific and Business Consultants, Inc., Atlanta, Ga.). American Institute of

Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-183. 12 p. 24 refs. Members, \$1.50; nonmembers, \$2.00.

The coupled unsteady turbulent boundary layer and potential flow about a pitching airfoil are analyzed using numerical methods to determine the effect of pitch rate on the delay in forward movement of the rear flow reversal point. An explicit finite difference scheme is used to integrate the unsteady boundary layer equations, which are coupled at each instant of time to a fully unsteady and nonlinear potential flow analysis. A substantial delay in forward movement of the reversal point is demonstrated with increasing pitch rate, and it is shown that the delay results partly from the alleviation of the gradients in the potential flow, and partly from the effects of unsteadiness in the boundary layer itself.

(Author)

A74-18838 * # Analysis of three-dimensional unsteady flow around oscillating wings. T. Bratanow and A. Ecer (Wisconsin, University, Milwaukee, Wis.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-184. 14 p. 19 refs. Members, \$1.50; nonmembers, \$2.00, Grant No. NGR-50-007-001.

A method based on the Navier-Stokes equations was developed for determining analytically the three-dimensional unsteady flow patterns around oscillating wings. The Helmholz vorticity transport equations were discretized in three-dimensional finite element form from a variational formulation and integrated numerically. At each time step of the numerical integration the velocity field was calculated from the representation of the three-dimensional wing by a system of optimized distribution of vortices in space. Ouring the numerical integration of the vorticity transport equations the time-dependent boundary conditions on the wing were specified as external constraint conditions. Examples of obtained results describing the three-dimensional unsteady flow around a wing were presented. (Author)

A74-18841 * # Application of an improved unified subsonic supersonic potential flow method for the aerodynamic analysis of aircraft configurations. C. H. Fox, Jr. (NASA, Langley Research Center, Hampton, Va.) and W. J. Breedlove, Jr. (Old Dominion University, Norfolk, Va.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-186. 5 p. Members, \$1.50; nonmembers, \$2.00.

F. A. Woodward, under contract to the NASA Langley Research Center, has recently formulated a distributed vortex aerodynamic singularity and developed an improved unified subsonic-supersonic potential flow computer program employing this singularity. This improved program is applicable to the prediction of the local surface pressure distribution for a large class of essentially arbitrarily shaped aircraft configurations. Results are presented for two classes of aircraft configurations of current interest: a maneuvering fighter type and a supersonic transport type. Comparison of these results with experiment indicate the program has good prediction capability.

(Author)

A74:18843 # Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus. C. W. Brix, Jr. and M. F. Platzer (U.S. Naval Postgraduate School, Monterey, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-14. 7 p. 12 refs. Members, \$1.50; nonmembers, \$2.00. Navy-supported research.

Supersonic flow past finite oscillating flat-plate cascades with subsonic leading-edge locus is analyzed using a linearized characteristics method. Blade pressure distributions are computed for arbitrarily specified free-stream Mach number, solidity, stagger angle, frequency of oscillation and interblade phase angle. Comparisons

with an alternate solution for a two-blade cascade using the method of singularities and a combined analytical/finite difference solution by J. M. Verdon show good agreement. (Author)

A74-18851 # Multi-surface system for the CCV B-52. R. D. Poyneer (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-126. 6 p. 8 refs. Members, \$1.50; nonmembers, \$2.00.

This paper summarizes an analytical study conducted by the Control Configured Vehicles (CCV) technical staff to synthesize a CCV Multi-Surface System (MSS) for the CCV B-52 airplane. Quadratic optimal control theory was used to design a multiple-input, multiple-output controller for the lateral-directional axis, The controller used five sensors and four aerodynamic control surfaces to reduce accelerations, and stresses on the B-52. This paper covers the design requirements, and constraints, design procedure, and the study results. The results show that the MSS performs better than the individually designed concepts of Ride Control and Lateral Augmented Stability (RCS/LAS). (Author)

A74-18852 * # Lift-induced wing-tip vortex attenuation. J. C. Patterson, Jr. (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-38. 7 p. Members, \$1.50; nonmembers, \$2.00.

It has been shown by a new static airflow visualization method that a drogue device properly positioned downstream of the wing tip causes vortex breakdown. This same result has been obtained by mounting a jet engine simulator at the wing tip and directing the high-energy jet blast downstream into the vortex. These configurations, among others, are now under intensive investigation in the new Langley Vortex Research Facility. In this facility a balance mounted vortex generating model is propelled along the 1800-foot track while a second model trailed at 160 feet (scale distance of 1 mile) measures the far-field rolling moment induced by the vortex of the generating model. (Author)

A74-18855 # The effect of inlet distortion on the performance and stability of the low-speed spool of a turbofan engine. J. A. Korn (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-234. 12 p. Members, \$1.50; nonmembers, \$2.00.

A74-18858 * # Fracture mechanics /Dryden Lecture/. H. F. Hardrath (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-230. 11 p. 33 refs. Members, \$1.50; nonmembers, \$2.00.

A historical outline of the engineering discipline of fracture mechanics is presented, and current analytical procedures are summarized. The current status of the discipline is assessed, and engineering applications are discussed, along with recommended directions for future study.

M.V.E.

A74-18865 # Automatic Flight Control System development for U.S. Army heavy lift helicopter. J. W. Gaul, E. D. Diamond, and J. M. Davis (Boeing Vertol Co., Philadelphia, Pa.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-25. 8 p. Members, \$1.50; nonmembers, \$2.00.

A fail-operational Automatic Flight Control System (AFCS) is being developed for the Army Heavy Lift Helicopter. The heart of the system consists of triplex digital computers which process

identical sensor and navigation/guidance inputs to generate both differential and parallel command outputs. A developmental system has been built for initial testing in a modified CH-47. This system utilizes incremental serial digital computers with cross-channel, bit-by-bit processing synchronization; median signal select for sensor inputs; failure monitoring with auto shutdown at the system, axis, and control mode levels; and off-line BITE. Initial flight testing will begin in February, 1974. (Author)

A74-18877 # Three dimensional supersonic flow field analysis of the B-1 airplane by a finite difference technique and comparison with experimental data. L. D'Attorre, M. A. Bilyk, and R. J. Sergeant (TRW Systems Group, Redondo Beach, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-189. 23 p. 10 refs. Members, \$1.50; nonmembers, \$2.00. Contracts No. F33657-71-C-1055; No. F33657-73-C-0058.

A finite difference, artificial viscosity computer code has been successfully utilized to calculate numerically the 3-dimensional flow field over the B-1 bomber. For the Mach numbers considered (1.6 and 2.2), an excellent correlation has been obtained between the theory and experimental wind tunnel data. Vehicle local surface pressure, surface flow field (oil flow) and shock wave locations are all predicted quite accurately. The near and far flow field cross flow, vortex flow, shock interactions and exhaust jet interference were also determined. The airplane shape was represented numerically by the exact cross-section coordinates which define the actual shape of the vehicle.

(Author)

A74-18981 * # Electronic displays and digital automatic control in advanced terminal area operations. S. Salmirs (NASA, Langley Research Center, Hampton, Va.) and H. N. Tobic (Boeing Commercial Airplane Co., Seattle, Wash.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-27. 8 p. Members, \$1.50; nonmembers, \$2.00.

A74-18882 # Evaluation of aircraft departure divergence criteria with a six-degree-of-freedom digital simulation program. R. J. Pelikan (McDonnell Aircraft Co., St. Louis, Mo.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-58. 8 p. Members, \$1.50; nonmembers. \$2.00.

A74-18897 Investigations concerning wing-fuselage interference in the case of subsonic velocity (Untersuchungen zur Flügel-Rumpf-Interferenz bei Unterschallgeschwindigkeit). H. Körner, S. R. Ahmed, and R. Müller (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). DFVLR-Nachrichten, Dec. 1973, p. 509-511. In German.

It is pointed out that in modern subsonic commercial aircraft the fuselage has a considerable effect on the distribution of the pressure to which the wing area is subjected. Theoretical studies conducted to investigate this effect are discussed, giving attention to the development of a computational approach for a wing-fuselage combination with a circular fuselage. The further development of a procedure for computations in the case of complete aircraft configurations of arbitrary geometry is also considered. The theoretical studies have been supplemented with experimental investigations in three different wind tunnels.

G.R.

A74-18901 A new ILS localizer for regional airports (Neuer ILS-Landekurssender für Regionalflugplätze). W. Fogy, M. Raab, M. Mozer, and R. Stoiber (Deutsche Forschungs und Versuchsanstalt für Luft und Raumfahrt, Institut für Flugfunk und Mikrowellen and Institut für Satellitenelektronik, Oberpfaffenhofen,

West Germany). DFVLR-Nachrichten, Dec. 1973, p. 517, 518. In German.

The new installation described employs two horizontal dipoles. The antennas provide the basis of an interferometer. The third antenna of the conventional localizer is not required by the new system. Tests show that difficulties occurring in connection with certain weather conditions and ground characteristics can be overcome by relatively simple means. Technical problems regarding the phase and amplitude constancy have been solved. Electronic details concerning the new localizer are examined.

G.R.

A74-18902 # The Alpha Jet programme, P. Kania. Dornier-Post (English Edition), no. 4, 1973, p. 3-10.

The Alpha Jet aircraft is being developed by Dassault-Breguet and Dornier as a joint German-French venture. The Alpha Jet is to be built in two almost identical versions including close air support aircraft for the German Air Force and a trainer for the French Air Force. The early program phases are discussed together with the development phase and aspects of flight testing. The first production aircraft are scheduled for delivery toward the end of 1976. It is pointed out that an aircraft of the Alpha Jet class would have good export prospects. Only conventional methods and familiar materials are to be used in producing the aircraft.

G.R.

A74-18925 Supersonic fuels from medium oils produced by the thermal cracking of crude oil residues (Überschallkraftstoffe aus Mittelölen der thermischen Krackung von Rohölrückständen). R. Erlmeier (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugtreib- und Schmierstoffe, Munich, West Germany) and E. Meisenburg (Union Rheinische Braunkohlen Kraftstoff AG, Wesseling, West Germany). Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie, vol. 26, June 1973, p. 334-338. 10 refs. In German, (DFVLR-SONDDR-301)

The processing steps involved in obtaining the fuels are discussed, taking into account distillation, hydrogenation, and refining procedures. Attention is given to the effect of n-paraffins and aromatic compounds on the fuel characteristics. The composition of the fuels was determined by analytical procedures which included thermodiffusion and NMR measurements. The properties of the fuels are compared with the requirements for fuels on a hydrocarbon basis which are to be used for velocities at Mach number 3. The investigation shows that the considered approach can provide suitable fuels for supersonic flight applications.

G.R.

A74-18987 On the modes of icing of symmetrical lifting surfaces. A. M. Mkhitarian, V. A. Kas'ianov, L. P. Goliakov, and Iu. G. Koval' (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). (Gidromekhanika, vol. 21, 1972, p. 60-65.) Fluid Mechanics - Soviet Research, vol. 2, Nov.-Dec. 1973, p. 151-156. Translation.

A method is presented which allows one to investigate the form of ice forming on the tip of simple aerodynamic shapes placed in a monodisperse aerosol flow under conditions of instantaneous glaciation of the captured particles. This method is used for obtaining diagrams of zones of types of icing for theoretical shapes formed by a 'source-sink' system of identical strength and by a 'source-uniformly distributed sink array' system.

(Author)

A74-18998 T700 aims at low combat maintenance. M. L. Yaffee. Aviation Week and Space Technology, vol. 100, Jan. 28, 1974, p. 45, 47-49.

The described T700-Ge-700 engine under development is a small compact turboshaft engine. The 15-sph engine has been selected by the Army to power its utility tactical transport aircraft and advanced attack helicopter. A distinctive feature of the engine is an integral inlet particle separator which will operate all the time with the engine on and which is expected to reduce significantly engine maintenance on helicopters operating in severe combat environments.

A74-19051 # Computer prediction of aircraft noise. P. J. Dickinson (Southampton, University, Southampton, England). *Tech Air*, vol. 30, Jan. 1974, p. 9-11.

A mathematical computer model was designed to predict the economic impact of achieving reduced noise levels from aircraft. The program suite designed is shown in block form. Ten main programs are supplied with input data from three storage files. The first of these contains all the data relating to each aircraft type. The second file contains all the flight data at the airports under investigation. The third file includes a delimitation of each airport environ into five land usage categories.

G.R.

A74-19205 *# ... The S-3A - A new dimension in airborne sea control. R. R. Heppe, L. E. Channel, and C. W. Cook (Lockheed-California Co., Burbank, Calif.). American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 10th, Washington, D.C., Jan. 28-30, 1974, Paper 74-239. 12 p. Members, \$1.50; nonmembers, \$2.00.

The new S-3A patrol aircraft fills the requirement to replace the obsolescent and operationally inadequate S-2. The S-3A has been shown to offer major performance gains in all systems areas having significant impact on mission effectiveness. The gains in S-3A effectiveness are primarily attributable to the advanced data processing, sensors, and new integration features which, in combination, comprise the central most important system capability in the S-3A. These additional capabilities, in turn, make it possible to utilize increased numbers of sonobuoys and additional weapons capabilities to further enhance effectiveness.

STAR ENTRIES

N74-13701 Maryland Univ., College Park. ARTIFICIAL DEVELOPMENT OF AN ATMOSPHERIC BOUNDARY LAYER FLOW MODEL IN A WIND TUNNEL Ph.D. Thesis

Fredric Allen Godshall 1973 117 p

Avail: Univ. Microfilms Order No. 73-23725

A wind flow model of the atmospheric boundary layer may be produced in a wind tunnel. With the use of wind flow modulating devices placed in the tunnel entrance, a thick flow model may be produced at the entrance to the tunnel. Thus a long wind fetch in the tunnel is not needed to produce the thick boundary layer model. In this experiment a thermally stable boundary layer wind flow model was produced for the purpose of studying atmospheric diffusion. Hot wire anemometry and cold wire temperature measuring equipment are used to measure vertical heat and momentum flux in the model. These fluxes are used to compute a flux value for L which is found to be equal to the gradient determined value of L. The suitability of the model for study of atmospheric diffusion is demonstrated by this test of eddy flux in the model. Dissert, Abstr.

N74-13702 Notre Dame Univ., Ind.
THE DETERMINATION OF NON-SYMMETRIC VEHICLE STABILITY PARAMETERS FROM RESPONSE DATA Ph.D. Thesis

Robert John Lusardi 1973 145 p Avail: Univ. Microfilms Order No. 73-24322

Methods are presented for the determination of the parameters of ordinary differential equations from response data. Application is made to the angular motion of a non-symmetric flight vehicle. In particular, the supposedly symmetric spinning body of revolution is investigated to show that those parameters which depend on the dynamic flow field are not governed by the symmetry Dissert. Abstr. assumption.

N74-13706*# Scientific Translation Service, Santa Barbara, Calif

THE INSTITUTE FOR FLIGHT MECHANICS, BRAUN-SCHWEIG (081) AND STUTTGART (027)

Washington NASA Dec. 1973 69 p refs Transl into ENGLISH from the German report

(Contract NASw-2483)

(NASA-TT-F-15197) Avail: NTIS HC \$5.50 CSCL 01A

The Institute of Flight Mechanics of the DFVLR is engaged in theoretical and experimental works on the solution of flight dynamic problems predominantly in the field of aeronautics. In the field of flight dynamics of aircraft, emphasis is on the project of a variable stability aircraft using the HFB 320-S1 research aircraft. Thus important flight test data may be obtained for current research activities supporting the improvement of methods to predict aircraft performance and handling qualities. Further, emphasis is laid on investigations of rescue and recovery systems. Drop tests, model tests and theoretical investigations, run side by side, to approach the solutions of the numerous problems (such as function, dynamic behavior, strength). Finally, system analyses and system evaluations are performed with probabilistic and operations research methods in cooperation with other Author institutes.

N74-13707*# Kanner (Leo) Associates, Redwood City, Calif. CALCULATION OF POTENTIAL FLOW ABOUT AXIALLY SYMMETRIC FUSELAGES, ANNULAR PROFILES AND ENGINE INLETS

W. Geissler Washington NASA Dec. 1973 16 p refs Transl. into ENGLISH from Z. Flugwissenschaften (West Germany), v. 20, no. 12, Dec. 1972 p 457-462

(Contract NASw-2481)

(NASA-TT-F-15213) Avail: NTIS HC \$3.00 CSCL 01A

The calculation of the potential flow about bodies of revolution (closed bodies, inlets, cowis) is done by a method using surface distributions of sources, sinks, and vortices. This method deals with the case of an arbitrary flow about the body. Besides axisymmetric flows and flows at incidence to the body axis, it is possible to take care of the flow field induced by another bod (interference problem). A panel method is used for the numerical solution of the problem. In the case of an axisymmetric body, the surface elements are frustums of cones of small axial length. For different types of bodies the results of this method are compared with measurements.

N74-13708*# Avco Corp., Wilmington, Mass. Systems Div. ANALYSIS OF STALL FLUTTER OF A HELICOPTER RADAR **BLADE** Final Report

Peter Crimi Washington NASA Nov. 1973 134 p refs Sponsored in part by USAAMRDL

(Contract NAS1-11378)

(NASA-CR-2322) Avail: NTIS HC \$4.50 CSCL 01C

A study of rotor blade aeroelastic stability was carried out, using an analytic model of a two-dimensional airfoil undergoing dynamic stall and an elastomechanical representation including flapping, flapwise bending and torsional degrees of freedom. Results for a hovering rotor demonstrated that the models used are capable of reproducing both classical and stall flutter. The minimum rotor speed for the occurrence of stall flutter in hover, was found to be determined from coupling between torsion and flapping. Instabilities analogous to both classical and stall flutter were found to occur in forward flight. However, the large stall-related torsional oscillations which commonly limit aircraft forward speed appear to be the response to rapid changes in perodynamic moment which accompany stall and unstall, rather in the result of an aeroelastic instability. The severity of II-related instabilities and response was found to depend to ne extent on linear stability. Increasing linear stability lessens the susceptibility to stall flutter and reduced the magnitude of the torsional response to stall and unstall.

N74-13709*# Advisory Group for Aerospace Research and Development, Paris (France).

DYNAMIC STALL

P. Crimi (Avco Corp., Wilmington, Mass.) and P. F. Yaggy, ed. (Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.) Nov. 1973 41 p refs Sponsored by NASA (NASA-CR-136473; AGARD-AG-172) Avail: NTIS HC \$4.25 CSCL 01A

Problems associated with unsteady stall are summarized and past experimental and theoretical studies, relating primarily to dynamic stall of helicopter rotor blades, are reviewed. The problems attendant to analytic treatment of dynamic stall, including identification of relevant flow elements and definition of unsteady separation, are then discussed, and the basis for a theory which accounts for viscous effects and viscous-inviscid interactions analytically is presented. Results of computations are compared with measured loading on an airfoil undergoing sinusoidal pitching motion. The amounts of lift overshoot and their variation with frequency are in good agreement. Analyses of wake-induced stall and stall flutter of a helicopter rotor blade are then presented. The results indicate that the large stall-related torsional oscillations which commonly limit helicopter forward speed are the response to rapid changes in aerodynamic moment which accompany stall and unstall, rather than the consequence of an aeroelastic Author instability.

N74-13710# Advisory Group for Aerospace Research and Development, Paris (France). MAGNUS CHARACTERISTICS OF ARBITRARY ROTATING

BODIES

I. D. Jacobson (Va. Univ.) and P. F. Yaggy, ed. (Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.) Nov. 1973 62 p refs

(AGARD-AG-171) Avail: NTIS HC \$5.25

Theoretical and experimental investigations of the Magnus effect on arbitrary bodies of revolution are reviewed. The main emphasis is on spinning projectiles at angle of attack, both with and without fins. Flow visualization measurements are used to assess the accuracy of the existing theories. Laminar, turbulent, and mixed boundary layers are considered.

Author

N74-13713 West Virginia Univ., Morgantown. THE STABILITY OF HELICAL VORTEX FILAMENTS IN THE WAKE OF A HOVERING ROTOR Ph.D. Thesis Ojars Skujins 1973 130 n

Avail: Univ. Microfilms Order No. 73-23891

The geometry and stability of the wake of a hovering rotor out of ground effect was investigated. A schlieren system in conjunction with a high speed drum camera was developed for this purpose, so that real time sequence photographs could be taken of the vortex filaments as they were convected downstream, with rotor azimuth angle increments as small as 15 degrees being possible between exposures. Two, three and four bladed 16 inch diameter rotors were used operating at rotor speeds of up to 9000 RPM. The effects of the various rotor parameters, such as rotor speed, number of blades, and collective pitch, were correlated with the stability of the vortex wake system. Factors including vortex instabilities are discussed.

Ñ74-13714 Georgia Inst. of Tech., Atlanta. EFFECT OF COMPRESSIBILITY ON THREE-DIMENSIONAL HELICOPTER ROTOR BLADE FLUTTER Ph.D. Thesis William Felton White 1973 94 p

Avail: Univ. Microfilms Order No. 73-22947

An analytical study is presented to determine a flutter criterion applicable to helicopter rotor blades. To accomplish this, it is necessary to establish the relative accuracy and computational efficiency of compressible unsteady aerodynamic theories applicable to rotor blades. Considerations are restricted to the classical flutter of an equivalent single rotor in hover at low inflow. Strip theory is used to compute aerodynamic loads. Comparison is made with experimental data. Dissert. Abstr.

N74-13715*# Stanford Univ., Calif. Guidance and Control Lab.

AUTOMATIC CONTROL OF A HELICOPTER WITH A HANGING LOAD

Narendra K. Gupta and Arthur E. Bryson, Jr. Jun. 1973 88 prefs

(Contract NAS2-5143)

(NASA-CR-136504; SUDAAR-459) Avail: NTIS HC\$6.50 CSCL

An autopilot logic is designed here for controlling a helicopter with a hanging load. A 16th order model for the system is decoupled into four subsystems: (1) a second order system for yawing motion, (2) a second order system for vertical motion, (3) a sixth order system for longitudinal motion, and (4) a sixth order system for lateral motion. A measuring scheme, which could be used in remote areas, is developed and filters are designed to estimate the state variables from these measurements. The autopilot can be used to move the load over short distances without retracting the cables. This is done by automatically shifting the autopilot modes from position-hold (hover) to acceleration-hold to velocity-hold (cruise) to deceleration-hold to velocity-hold (near hover) to position-hold (hover). Use of such an autopilot might save considerable turnaround time. The Sikorsky S-61 helicopter is chosen as an example vehicle. The performance of the controlled system is studied in the presence of longitudinal and lateral winds. Author

N74-13716# Cranfield Inst. of Technology (England). Coll. of Aeronautics.
PERFORMANCE CHARACTERISTICS OF SHORT HAUL
TRANSPORT AIRCRAFT INTENDED TO OPERATE FROM REDUCED LENGTH RUNWAYS

D. Howe Apr. 1973 32 p refs

(CRANFIELD-AERO-18) Avail: NTIS HC \$3.75

The design characteristics of future short haul transport aircraft intended to operate from runways of reduced length are compared to those used at the present time. The results show that it should be possible to design reduced take off and landing (RTOL) aircraft to operate safely from runways of 4000 ft length without the need for power augmented lift. Such an aircraft would operate at speeds very similar to those used by current short haul transports, the main difference being in the need to provide a static thrust/weight ratio of the order of 0.4. On the other hand short take off and landing (STOL) aircraft intended to operate from runways of about 2000 ft length require a substantial degree of powered lift both for take off and landing.

N74-13717*# Scientific Translation Service, Santa Barbara.

NEW TECHNOLOGIES AND PROFITABILITY OF HELICOPTERS

J. Andres Washington NASA Dec. 1973 54 p ref Transl. into ENGLISH of the paper presented at the AGARD Flight Mech. Panel Symp. Aircraft Design Integration and Optimization (Maignane, France). Oct. 1973 22 p (Contract NASw-2483)

(NASA-TT-F-15195) Avail: NTIS HC \$4.75 CSCL 01C

A study was conducted to determine the economic aspects of helicopter operation for commercial purposes. Concepts of specific cost and cost per kilogram provide the basis for the analysis. The fundamental characteristics of helicopters which determine its mission and profitability are discussed. Specific areas investigated are: (1) fatigue life of components. (2) noise reduction, (3) vibration reduction, (4) optimization of rotary wings, and (5) application of composite materials for helicopter construction.

N74-13718*# Boeing Co., Wichita, Kans.
THE INFLUENCE OF WING LOADING ON TURBOFAN
POWERED STOL TRANSPORTS WITH AND WITHOUT
EXTERNALLY BLOWN FLAPS Final Report

R. L. Morris, C. R. Hanke, L. H. Pasley, and W. J. Rohling Washington NASA Nov. 1973 165 p refs (Contract NAS1-11370)

(NASA-CR-2320; D3-8514-7) Avail: NTIS HC \$4.75 CSCL O1C

The effects of wing loading on the design of short takeoff and landing (STOL) transports using (1) mechanical flap systems. and (2) externally blown flap systems are determined. Aircraft incorporating each high-lift method are sized for field lengths of 2,000 feet, 2,500 feet, and 3,500 feet, and for payloads of 40, 150, and 300 passengers, for a total of 18 point-design aircraft. An assumed 1975 level of technology is applied to both concepts in terms of propulsion, weights, active controls, supercritical wing methodology, and acoustics. Low-wing-loading STOL configurations with mechanical flaps are found to be competitive with externally blown flap STOL configurations over wide ranges of payload and field length for the airworthiness rules and technology improvements assumed. Because the results of design studies like this one are sensitive to the ground rules assumed, careful attention is paid to describing the assumptions. These assumptions must be understood before the results are compared with other STOL airplane studies. Author

N74-13719*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. AERODYNAMIC AND NOISE MEASUREMENTS ON A QUASI-TWO DIMENSIONAL AUGMENTOR WING MODEL WITH LOBE-TYPE NOZZLES

Thomas N. Aiken Sep. 1973 77 p refs (NASA-TM-X-62237) Avail: NTIS HC \$6.00 CSCL 01C

An investigation was made of the static, wind-on aerodynamic and static, noise characteristics of an augmentor wing having lobe type nozzles. The study was made in the Ames 7-by 10-Foot No. 1 Wind Tunnel using a small-scale, quasi-two-dimensional model. Several configurations of lobe nozzles as well as a normal slot nozzle were tested. Results indicate that lobe nozzles offer improved static and wind-on aerodynamics and reduced static noise relative to slot nozzles. Best wind-on performance was obtained when the tertiary gap was closed even though the static thrust augmentation was maximum with the gap open. Static thrust augmentation, wind-on lift and drag, and static noise directivity are presented as well as typical static and wind-on exit velocity profiles, surface pressure distributions and noise spectrums. The data are presented with limited discussion.

N74-13720*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.

TAKEOFF AND LANDING PERFORMANCE AND NOISE MEASUREMENTS OF A DEFLECTED SLIPSTREAM STOL AIRPLANE WITH INTERCONNECTED PROPELLERS AND ROTATING CYLINDER FLAPS

James A. Weiberg, Demo Giulianetti, Bruno Gambucci, and Robert C. Innis Dec. 1973 58 p refs

(NASA-TM-X-62320) Avail: NTIS HC \$5.00 CSCL 01C

A YOV-10A aircraft was modified to incorporate rotating cylinder flaps and interconnected propellers with Lycoming T-53-L11 engines. Flight tests were made to evaluate the low speed handling qualities and performance characteristics. The flight test results indicated that landings could be made with approach speeds of 55 to 65 knots (CL = 4.5) and descent angles of 6 deg to 8 deg for total flap angles of 60 deg to 75 deg. At higher flap angles, deterioration of stability and control characteristics precluded attempts at landing. The noise level on the ground under an 8 deg landing approach path was below 86 PNdB at distances beyond 1 nautical mile from touchdown. Takeoffs were made with 30 deg to 45 deg flaps at lift off speeds of 75 to 80 knots and climb angles of 4 deg to 8 deg. Noise levels were below 83 PNdB at 3.5 nautical miles from the start of ground roll.

N74-13721*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

WIND TUNNEL INVESTIGATION OF A LARGE-SCALE 25 DEG SWEPT-WING JET TRANSPORT MODEL WITH AN EXTERNAL BLOWING TRIPLE-SLOTTED FLAP

Kiyoshi Aoyagi, Michael D. Falarski, and David G. Koenig Nov. 1973 59 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Moffett Field, Calif.

(NASA-TM-X-62197) Avail: NTIS HC \$5.00 CSCL 01C

An investigation has been conducted to determine the aerodynamic characteristics of a large-scale subsonic jet transport model with an externally blown triple-slotted flap. The lift of the model was augmented by the turbofan engine exhaust impingement on the flap surface. The model had a 25 deg swept wing of aspect ratio 7.28 and four turbofan engines. The model was tested with two flap extents. One extended from 0.11 to 1.00 of the wing semispan, and the other extended from 0.11 to 0.75 of the wing semispan with a single-slotted aileron from 0.75 to 1.00 of the wing semispan. The results were obtained for several flap deflections with and without the horizontal tail at gross thrust coefficients from 0 to 4.0. Longitudinal and lateral data are presented with three and four engines operating.

Author

N74-13722*# Giravions Dorand Co., Suresnes (France).
MARCH 1971 WIND TUNNEL TESTS OF THE DORAND
DH 2011 JET FLAP ROTOR, VOLUME 1 Final Report
Marcel Kretz, Jean-Noel Aubrun, and Marc Larche Jun. 1973
55 p refs 2 Vol.
(Contract NAS2-3673)

(NASA-CR-114693; DH-2011-D-E5-Vol-1) Avail: NTIS HC \$4.75

The results of wind tunnel tests, second series of tests performed in the NASA Ames 40 x 80 foot wind tunnel, of the DH 2011 jet-flap rotor are presented and analyzed. The tests have been focused on multicyclic effects and the capability of this rotor to reduce the vibratory loads and stresses in the blades. The reductions of the vibrations and stresses at tip speed ratio of 0.4 have attained 50%. The theory shows further reductions possible, reaching 80%. The results show that the performance characteristics after the modifications introduced since 1965 remained unchanged. The domain of investigation has been enlarged to include the tip speed ratios of 0.6 and 0.7. To analyze the complex aeroelastic phenomena a new analytical technique has been utilized to represent the mathematical model of the rotor. This technique, based on transfer matrices and transfer functions, appears very simple and it is believed that this analysis is applicable to many kinds of investigations involving large numbers of variables.

N74-13723*# Giravions Dorand Co., Suresnes (France).
MARCH 1971 WIND TUNNEL TESTS OF THE DORAND
DH 2011 JET FLAP MOTOR, VOLUME 2 Final Report
Marcel Kretz, Jean-Noel Aubrun, and Marc Larche Jun. 1973
151 p Sponsored in part by Army Air Mobility Lab. 2 Vol.
(Contract NAS2-3673)

(NASA-CR-114694; DH-2011-D-E5-Vol-2) Avail: NTIS HC \$9.75 CSCL 01C

Wind tunnel tests were conducted of the Dorand DH 2011D jet flap rotor. The data recorded during the tests consist of: {1} multicyclic cam coefficients, {2} stress analysis, {3} vibratory loads, {4} Fourier analysis of flap deflection, and (5) blade bending stress. Data are presented in the form of tables and graphs.

Author

N74-13724*# Boeing Co., Wichita, Kans.
DEVELOPMENTAL DESIGN, FABRICATION, AND TEST OF
ACOUSTIC SUPPRESSORS FOR FANS OF HIGH BYPASS
TURBOFAN ENGINES

R. H. Tucker, M. D. Nelsen, G. E. Gregg, and F. I. Palmer Washington NASA Jan. 1974 63 p refs (Contract NAS3-14321)

(NASA-CR-2338; D3-8952) Avail: NTIS HC \$3.50 CSCL 01C

An analysis procedure was developed for design of acoustically treated nacelles for high bypass turbofan engines. The plan was applied to the conceptual design of a nacelle for the quiet engine typical of a 707/DC-8 airplane installation. The resultant design was modified to a test nacelle design for the NASA Lewis quiet fan. The acoustic design goal was a 10 db reduction in effective perceived fan noise levels during takoff and approach. Detailed nacelle designs were subsequently developed for both the quiet engine and the quiet fan. The acoustic design goal for each nacelle was 15 db reductions in perceived fan noise levels from the inlet and fan duct. Acoustically treated nacelles were fabricated for the quiet engine and quiet fan for testing. Performance of selected inlet and fan duct lining configurations was experimentally evaluated in a flow duct. Results of the tests show that the Author linings perform as designed.

N74-13725*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif. FLIGHT STUDY OF A VEHICLE OPERATIONAL STATUS

FLIGHT STUDY OF A VEHICLE OPERATIONAL STATUS
AND MONITORING SYSTEM

James E. Love, William J. Fox (Lockheed-Calif. Co.), and Edward J. Wicklund (Honeywell, Inc.) Washington Jan. 1964 12 p (NASA-TN-D-7546; H-789) Avail: NTIS HC \$2.75 CSCL 01C

An analog onboard monitoring system was installed on a YF-12 airplane as the first phase of a program to monitor the engine inlet and portions of the airplane's electrical and fuel management subsystems in flight. The system provided data which were considered to form a suitable base for diagnostic test logic and decision criteria for the rest of the program. The data were

also adequate for the purpose of maintaining the engine inlet and identifying malfunctions within it. The investigation showed that the requirements of an onboard monitoring system should be considered during the original design of the system to be monitored.

N74-13726*# Hamilton Standard, Windsor Locks, Conn.
Q-FANSTM FOR GENERAL AVIATION AIRCRAFT
Rose Worobel and Millard G. Mayo Dec. 1973 267 p refs
{Contract NAS2-6834}

(NASA-CR-114665) Avail: NTIS HC \$15.50 CSCL 01C Continued growth of general aviation over the next 10 to 15 years is dependent on continuing improvement in aircraft safety, utility, performance and cost. Moreover, these advanced aircraft will need to conform to expected government regulations controlling propulsion system emissions and noise levels. An attractive compact low noise propulsor concept, the Q-FANTM when matched to piston, rotary combustion, or gas turbine engines opens up the exciting prospect of new, cleaner airframe designs for the next generation of general aviation aircraft which will provide these improvements and meet the expected noise and pollution restriction of the 1980 time period. New Q-FAN methodology which was derived to predict Q-FAN noise, weight and cost is presented. Based on this methodology Q-FAN propulsion system performance, weight, noise, and cost trends are discussed. Then the impact of this propulsion system type on the complete aircraft is investigated for several representative aircraft size categories. Finally, example conceptual designs for Q-FAN/engine integration and aircraft installations are presented.

N74-13727*# Boeing Vertol Co., Philadelphia, Pa.
V/STOL TILT ROTOR AIRCRAFT STUDY. VOLUME 10:
PERFORMANCE AND STABILITY TEST OF A 1-14.622
FROUDE SCALED BOEING VERTOL MODEL 222 TILT
ROTOR AIRCRAFT (PHASE 1)

F. J. McHugh, W. Eason, H. R. Alexander, and H. Mutter Oct. 1973 521 p refs 10 Vol.

(Contract NAS2-6598)

(NASA-CR-114603; D222-10053-1-Vol-10) Avail: NTIS HC \$28.25 CSCL 01C

Wind tunnel test data obtained from a 1/4.622 Froude scale Boeing Model 222 with a full span, two prop, tilt rotor, powered model in the Boeing V/STOL wind tunnel are reported. Data were taken in transition and cruise flight conditions and include performance, stability and control and blade loads information. The effects of the rotors, tail surfaces and airframe on the performance and stability are isolated as are the effects of the airframe on the rotors.

N74-13728# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

CONTROL CONFIGURED VEHICLE RIDE CONTROL (CCV RCS). B-52 CONTROL SYSTEM ANALYSIS, SYNTHESIS, AND DESIGN Technical Report. Dec. 1971 - Jan. 1973 C. R. Stockdale and R. D. Poyneer Jul. 1973 223 p refs (AF Proj. 487T)

(AD-767590; AFFDL-TR-73-83) Avail: NTIS CSCL 01/2

The Control Configured Vehicle Ride Control System Program was conducted to demonstrate the capability of significantly improving the ride quality of a large flexible airplane and lengthening its structural life. The ride control system employs both horizontal and vertical canards to be installed and flight tested on the B-52 LAMS vehicle. The analysis, design, and flight demonstration of the ride control system was directed toward one discrete flight condition, low level, high speed. The ride control system was designed to reduce pilot station acceleration while flying through atmospheric turbulence.

Author (GRA)

N74-13729# Little (Arthur D.), Inc., Cambridge, Mass.
FAILURE ANALYSIS OF HELICOPTER EXTERNAL CARGO-HANDLING SYSTEMS Final Report Robert E. Hunt Jun. 1973 168 p refs (Contract DAAJ02-72-C-0063; DA Proj. 1F1-62203-AA-33) (AD-767254; ADL-C-74645; USAAMRDL-TR-73-44) Avail: NTIS CSCL 01/3

A study of the failure of helicopter cargo-handling systems was conducted. A data search and compilation were completed from which the external cargo-handling system was defined and the system operation explained. Operational parameters were also defined and explained. Also criteria for assessing failures were established, data sources were cited, a search plan outlined and failure data and consensus data were retrieved and categorized. The data were taken primarily from cargo helicopters deployed in Vietnam. Their overall utilization, load categories, and rigging materials were determined, and a consensus summary of the cause of specific failures was compiled and documented. A data analysis was conducted with the relationship of failure occurrences and rates determined for specific types of accidents and failures. Predominant causes of failures were analyzed, a cost/value of relationship of cargo dropped established, and projections of the heavy-lift helicopter as a cargo carrier were made. Candidate corrective actions were recommended, with the development of specific corrective actions made, encompassing a collapsible cargo net-pallet concept and an investigation of cargo hook design principles. Author (GRA)

N74-13730# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.
NOISE GENERATION BY CYLINDRICAL SPOILERS IMMERSED IN AN AIR DUCT Interim Technical Report T. M. Tower, Edelbert G. Plett, H. H. Chiu, and Martin Summerfield Mar. 1973 255 p refs (Contract NO0014-67-A-0151-0029)

(AD-767336: AMS-1092) Avail: NTIS CSCL 01/3
The report describes a study concerned with the affect of thin cylindrical flow spoilers upstream of the exit plane of a constant-area duct on the acoustic power output and directivity patterns of the noise field external to the duct. Spoilers of diameter 1/16, 5/32, and 3/16 in. were placed at 1/8 in. and 11 in. from the exit plane of a 1 in. diameter duct. Far-field sound pressure levels were measured in an anechoic chamber over a mean velocity range of 250 to 900 ft/s. The frequency range of the investigation was 200 Hz to 50 kHz, while the Reynolds number range, based on mean velocity upstream of the spoiler and on spoiler diameter, was 8000 to 80.000. (Modified author abstract)

N74-13731# Systems Associates, Inc., Long Beach, Calif.
US ARMY HELICOPTER HYDRAULIC SERVOCYLINDER
RELIABILITY AND MAINTAINABILITY INVESTIGATION
Final Report

James L. Huffman and Sheldon Dockswell May 1973 148 p refs

(Contract DAAJ02-71-D-0003; DA Proj. 1F1-62205-A-119) (AD-767243; SAI-R73-009; USAAMRDL-TR-73-29) Avail: NTIS CSCL 13/7

The report describes an investigation carried out to identify. isolate, and verify the causes of problems with hydraulic servocylinder actuators used on U.S. Army helicopters, and to trace the resulting effects on helicopter availability. Design requirements, quality assurance provisions, maintenance procedures and practices were analyzed to assess their impact upon the current problems. The analysis of the pertinent failure data and documentation revealed that five failure modes were responsible for over 90% of the total hydraulic servocylinder removals in a 6 1/2-year period. Subsequent analysis of the various policies, practices and procedures showed that these documents contain anomalies that contribute to the occurrence of the five predominant failure modes. The lack of stringent basic design requirements, quality control, and adequate maintenance manuals was shown to be a major contributor to the leaking failure mode. This mode accounts for approximately half of the servocylinder removals from U.S. Army helicopters.

N74-13732# . Boeing Vertol Co., Philadelphia, Pa. TRANSMISSION THERMAL MAPPING (CH-47C FORWARD ROTOR TRANSMISSION) Final Report

Rocco C. Tocci, A. J. Lemanski, and Nelson J. Ayoub May

1973 170 p refs

(Contract DAAJ02-72-C-0075; DA Proj. 1G1-62207-AA-72) (AD-767875; D210-10545-1; USAAMRDL-TR-73-24) Avail: NTIS CSCL 01/3

The report presents the results of tests conducted to obtain the thermal maps of a CH-47C helicopter forward rotor transmission. The tests were conducted at several torque levels and to several controlled oil-out target temperatures. Thermal growth between selected points on the transmission case was Author (GRA) measured and analyzed.

N74-13733# General Dynamics/Convair, San Diego, Calif.
STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME
2: DESIGN COMPENDIUM Final Report, 7 Jun. 1971 -31 Jan. 1973

J. Herbert, Jr., E. S. Levinsky, J. C. Ramsey, E. C. Laudeman, and H. G. Altman May 1973 273 p refs (Contract F33615-71-C-1754; AF Proj. 643A)

(AD-767561; GDCA-DHG73-001-Vol-2;

AFFDL-TR-73-21-Vol-2) Avail: NTIS CSCL 01/1

The design compendium presents methods for estimating the aerodynamic and stability and control characteristics of mechanical flaps and the three lift/propulsion systems: mechanical flaps plus vectored thrust, externally blown flaps, and internally blown flaps. A review of various theoretical approaches is presented to form a basis for the generalized methods that are developed to estimate lift, drag, pitching moment, downwash, and the lateral-directional stability derivatives. Sample problems are presented to allow the most advantageous utilization of the methodology. The data correlations shown at the end of the major sections verify and substantiate the selected approaches. A general methodology has been developed for predicting the low speed aerodynamic and stability characteristics of STOL transport aircraft. The methodology is applicable to the EBF, IBF, and MF/VT STOL concepts. The basic procedures, which predict the lift curve versus angle of attack, maximum lift coefficient, induced drag, thrust recovery, pitching moment, and downwash angle are easily hand-calculated for a single case or programmed on a small computer to calculate a large number Author (GRA) of configurations.

N74-13734# General Dynamics/Convair, San Diego, Calif. STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 4: WIND TUNNEL DATA ANALYSIS Final Report, 7 Jun. 1971 - 31 Jan. 1973

J. Herbert, Jr., J. C. Ramsey, E. C. Laudeman, C. A. Whitney, and N. A. Pondmareff May 1973 406 p refs (Contract F33615-71-C-1754; AF Proj. 643A) (AD-767363; GDCA-DHG73-001-Vol-4;

AFFDL-TR-73-21-Vol-4) Avail: NTIS CSCL 01/3

Force and rake information measured during 1087 hours of low speed wind tunnel testing conducted by Convair Aerospace are summarized. Over 2730 data runs were generated on 242 major configuration variables that covered the following lift/ propulsion concepts: mechanical flaps plus vectored thrust, externally blown flaps, and internally blown flaps. Lift data was reduced into three basic terms: power-on to power-off lift curve slope ratio, trailing edge flap lift increment at alpha = zero degrees, and maximum lift coefficient increment due to the application of power. These relationships were evaluated as a function of blowing momentum coefficient and correlated for the effects of configurational variations (wing planform, leading and trailing edges, and nacelle location). Drag data was reduced into the form of induced drag factor, minimum profile drag, thrust recovery and then analyzed as a function of blowing momentum coefficient. The pitching moment data analysis compares the flap pitching moment increment among the various configurations. (Modified author abstract)

N74-13735# General Dynamics/Convair, San Diego, Calif. STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 5: FLIGHT CONTROL TECHNOLOGY Final Report, 7 Jun. 1971 - 31 Jan. 1973

J. Hebert, Jr., G. Campbell, E. Price, L. B. White, and R. Aalstenberg

May 1973 347 p refs (Contract F33615-71-C-1754; AF Proj. 643A)

(AD-767364; GDCA-DHG73-001-Vol-5;

AFFDL-TR-73-21-Vol-5) Avail: NTIS CSCL 01/3

Flight control studies conducted during the STOL Tactical Aircraft Investigation by Convair Aerospace were directed toward development of flight control systems for three versions of the medium STOL transport. Baseline vehicles used for flight control studies were: externally blown flap, internally blown flap, and mechanical flap/vectored thrust configurations. Requirements of MIL-F-8785B and MIL-F-833000 for aircraft handling qualities were the guiding criteria for the control system The mechanization trade study concluded that fly-bywire mechanization is preferred over the more mechanical version which requires significant fly-by-wire features to achieve the required augmentation and decoupling. (Modified author abstract)

N74-13736# General Dynamics/Convair, San Diego, Calif. STOL TACTICAL AIRCRAFT INVESTIGATION. VOLUME 6: AIR CUSHION AND GROUND MOBILITY STUDY Final

Report, 7 Jun. 1971 - 31 Jan. 1973 J. Herbert, Jr., H. Weber, G. T. Draper, C. Kerr, Jr., and T. F. Reid May 1973 43 p refs

(Contract F33615-71-C-1754; AF Proj. 643A)

(AD-767300; GDCA-DHG73-001-Vol-6; AFFDL-TR-73-21-Vol-6) Avail: NTIS CSCL 01/3

The air cushion landing system for the STOL transport aircraft is discussed. The configuration includes a rubber-nylon, torusshaped trunk attached to the lower portion of the fuselage. Air is supplied to the trunk by turbosheft-driven fans. It is then exhausted through rows of holes along the trunk ground tangent. Aircraft weight is distributed over the cushion area providing the desired low ground pressure. After liftoff, the trunk is deflated and retracts into the fuselage by elastic action.

N74-13737# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div. OPTIMAL CAPABILITIES OF HYPERSONIC PASSENGER

AIRCRAFT ON KEROSENE FUEL Ya. N. Gaukham 12 Sep. 1973 25 p Transl. into ENGLISH from Sb. Aerodin, Sverkhzvukovykh Samoletov (USSR), v. 2, no. 182, 1971 p 14-30

(AD-767887; FTD-HT-23-801-73) Avail: NTIS CSCL 01/3 The report evaluates the optimum flight characteristics of a GRA hypersonic aircraft using kerosene fuel.

N74-13738# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FLIGHT CONTROL OF AIRPLANES AND HELICOPTERS V. T. Borodin and G. I. Rylskii 27 Sep. 1973 342 p refs Transl. into ENGLISH of the publ. "Upravlenie Poletom Samoletov i Vertoletov" Moscow, 1972 p 1-238 (AD-767943; FTD-MT-24-318-73) Avail: NTIS CSCL 01/3

In the report an analysis is given and fundamental results systematized from foreign investigations on the development of promising means of automation of flight control of aircraft and helicopters. Structural diagrams and descriptions of the control systems of contemporary aircraft and helicopters, flexible aircraft, and also adaptive (self-adjusting, with variable structure, self-organizing) aviation systems are given. Bionic principles of adaptation and the possibility of their use in control systems of aircraft, and also the problems of automation of landing, flight on low and maximally low altitudes, and the arrangement of installed equipment are examined. Methods of reflecting flight information to the pilot, the systems of semiautomatic control, systems for the prevention of collisions of aircraft in the air. landing systems, profile flight and the contemporary complexes of installed equipment are described.

N74-13739# Naval Postgraduate School, Monterey, Calif. A MODIFIED DESIGN CONCEPT, UTILIZING DECK MOTION PREDICTION, FOR THE A-7E AUTOMATIC CARRIER LANDING SYSTEM M.S. Thesis

Thomas Maxwell Judd Jun. 1973 75 p refs (AD-767691) Avail. NTIS CSCL 01/2

The present concept of automatic carrier landings, Mode I operational capability, as employed in Navy carrier-based aircraft. was investigated. The aircraft chosen for study was the A-7E. The A-7E All Weather Carrier Landing System (AWCLS) and the carrier landing environment including burble effects and deck motion were simulated. Height of hook above ramp, touchdown point, and velocity of impact dispersions were determined. The current system was then modified, utilizing the concept of a SPN-42 Deck Motion Compensation Lead Computer which operates on the basis of known aircraft characteristics and predicted carrier heave motion. Simulation showed that automatic carrier landing performance as measured by number of ramp strikes, hard landings, and bolters could be improved. The modifications suggested require only a minimum of component additions to the AWCLS currently in use in the Navv Author (GRA)

N74-13740# Army Material Command, Texarkana, Tex. Intern Training Center

MINIMUM LIFE CYCLE COSTING FOR A VISTOL TRANS-PORT

Thomas W. Smith 1973 120 p refs

(AD-768133; USAMC-ITC-1-73-21) Avail: NTIS CSCL 01/3 The report proposes a new methodology for life cycle costing, In particular, a Vertical/Short Take-off and Landing (V/STOL) transport aircraft is considered. The costs included are those of research and development, production, maintenance, and operation. The minimum cost is found by the minimization of a function of three variables; maximum speed at best altitude. gross take-off weight, and maximum thrust per engine. Several methods of minimization were investigated, including geometric programming, Sequential Unconstrained Minimization Technique (SUMT), and the pattern search technique. The latter method was used with success and numerous computer runs were executed. The impact of the variation of many input parameters is shown in the results.

N74-13741# Sanders Nuclear Corp., Nashua, N.H. TACTILE DISPLAY FOR AIRCRAFT CONTROL Final Technical Report, 1 Jul. 1972 - 31 Aug. 1973

Author (GRA)

Don H. Ross, Richard A. Sanneman, William H. Levison, Robert B. Tanner, and Thomas J. Triggs 31 Aug. 1973 97 p refs Prepared in cooperation with Bolt, Beranek and Newman, Inc., Cambridge, Mass.

[Contract N00014-73-C-0031; ARPA Order 2108; NR Proj. 196-123)

(AD-767763) Avail: NTIS CSCL 01/4

The final report presents a set of manual tracking experiments that have been conducted to determine the suitability of tactual displays for presenting flight-control information in multi-task situations. Although tracking error scores are considerably greater than scores obtained with a continuous visual display, preliminary results indicate the inter-task interference effects are substantially less with the tactual display in situations that impose high visual scanning workloads. The single-task performance degradation found with the tactual display appears to be a result of the coding scheme rather than the use of the tactual sensory mode per se. Analysis with the state-variable pilot/vehicle model shows that reliable predictions of tracking errors can be obtained for a limited set of system configurations once the pilot-related model parameters have been adjusted to reflect the pilot-display interaction. Author (GRA)

N74-13742# Naval Aerospace Medical Research Lab., Pensacola.

ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1970: RELATIVE INCIDENCE AND COST

Jorma I. Niven, W. Carroll Hixson, and Emil Spezia 14 Sep. 1973 36 p refs (MF51524005)

(AD-768307: NAMRL-1192: USAARL-74-5) Avail NTIS CSCL 01/2

The report is the fourth in a series of reports dealing with pilot disorientation/vertigo accident problem is Regular Army UH-1 helicopter operations. Incidence and cost data presented for fiscal year 1970 include a total of 43 major and minor orientation-error, accidents (17 of which were fatal), resulting in 66 fatalities, 67 nonfatal injuries, and a total UH-1 aircraft damage cost of \$7,706,191 Author (GRA)

N74-13743# Army Natick Labs., Mass. Clothing and Personal Life Support Equipment Lab

ENGINEERING EVALUATION OF AGE LIFE EXTENSION. T-10 HARNESSES, RISERS AND T-10 TROOP CHEST RESERVE PARACHUTE CANOPIES. SUPPLEMENT 1: 1964 - 1965 YEAR CLASSES

Michael E. Mahar, Vasant K. Devarakonda, and Richard D. Wells Oct. 1973 23 p

(AD-767711; C/PLSEL-112-Suppl-1-

USA-NLABS-TR-74-9-CE-Suppl-1) Avail: NTIS CSCL 01/3 An engineering evaluation of T-10 troop-type harnesses, risers, and chest reserve parachute assemblies of year classes (dates of manufacture) 1964 and 1965 was conducted by laboratory testing of component materials. The data obtained from limited samplings from Fort Bragg. No. Carolina, Alaska and the Panama Canal Zone indicated a generally serviceable condition for this equipment at nine and eight years of total age. Taken with more extensive data and with the technical background and criteria developed in the earlier basic report 72-59-CE, (DDC AD 742-668) of the same title, dated March 1972, it was concluded that the recently extended 13 year (risers and harnesses) and 12 year (canopy assemblies) limits are fully substantiated for these 1964-65 classes. Subject to later check testing, further extension of the age life limit may be found appropriate. Author (GRA)

N74-13744# Air Force Inst. of Tech., Wright-Patterson AFB. Ohio. School of Engineering. A PRELIMINARY DESIGN OF A REMOTELY-CONTROLLED GLIDER FOR A LONG-LINE OPERATION M.S. Thesis

Elbridge Lee Snapp. III Jun. 1973 106 p refs (AD-767879; GA/AE/71-1) Avail: NTIS CSCL 01/3

Low-level, covert observation of a small area of ground may be obtained by an unmanned glider towed from a large aircraft and suspended in Long-Line-Loiter. This glider is equipped with a Visually-Coupled Control System operated through a Low-Light-Level Television camera. The glider has a gross weight of 442.5 lb of which 282.3 lb is payload. The vehicle features a high wing and a constant-chord airfoil with 30 ft span. Overall vehicle length is 17.7 ft. Wings-level stall speed is 35.8 knots. The glider exhibits static longitudinal, lateral, and directional stability. Attaching the tow cable to the top of the fuselage above the vehicle center of gravity allows the glider to be flown in high-speed trail or suspended in Long-Line-Loiter.

Author (GRA)

N74-13745# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.

PRODUCTION DATA PACKAGE 267 GALLON EXTERNAL FUEL TANK

Albert E. Simkins 23 Aug. 1973 28 p refs (AD-767937: NADC-73147-30) Avail: NTIS CSCL 01/3

A production data package was developed for a 267 gallon external fuel tank suitable for use on the F-14 aircraft.

Author (GRA)

N74-13746# Illinois Univ., Savoy. Aviation Research Lab. THE DESIGN AND FLIGHT EVALUATION OF A PERFORM-ANCE CONTROL SYSTEM M.S. Thesis Craig Alan Bergman Aug. 1973 68 p refs (Contract F44620-70-C-0105; AF Proj. 9778)

(AD-767786: ARL-73-16/AFOSR-73-10: AFOSR-73-1696TR) Avail: NTIS CSCL 01/3

A performance control system, which provides direct pilot control of vertical speed and bank angle, has been designed and flight tested in a twin-engine, general aviation aircraft. Automatic coordination and lift compensation in turns are provided. The system is FAA-certified for normal category operations under VFR conditions, above 400 feet AGL, with a qualified safety pilot. The operating ranges are plus or minus 1500 fpm vertical speed and plus or minus 60 degrees of bank angle. The system is insensitive to airspeed and altitude changes. Vertical speed accuracy is within 100 fpm for changes of power setting and landing gear extension/retraction. During flap changes and turning maneuvers the vertical speed changes by as much as 550 fpm, but recovery to within 100 fpm is accomplished within 20 seconds. Bank angle holding accuracy is approximately three Author (GRA) degrees for turns of standard rate or less.

N74-13747# Naval Postgraduate School, Monterey, Calif. THE SIMULATION AND ANALYSIS OF CARRIER LAND-INGS USING A NONLINEAR PILOT MODEL M.S. Thesis Clark Albert Wilson Jun. 1973 62 p refs (AD-767679) Avail: NTIS CSCL 01/2

The report investigated the interaction of the pilot and the Fresnel lens optical landing system (FLOLS) with the aircraft system dynamics of a carrier landing and attempted to determine whether or not the dynamics of the FLOLS contributed to a nosedown command by the pilot when approaching touchdown. With the assumption of a nonlinear pilot model, the entire system's equations of motion were programmed on an analog computer and time histories of approaches for various pilot gains were recorded and analyzed. Results obtained showed that the stability of the entire system near touchdown was very sensitive to gains which the pilot adopted. Also, because of the lag in the FLOLS dynamics, the pilot would, for some pilot gains, input a definite nosedown command to counteract a rising meatball on the FLOLS display. The typical result of such a command is a hard landing Author (GRA) or ramp strike.

N74-13748# Naval Postgraduate School, Monterey, Calif. THE DESIGN, FABRICATION AND EVALUATION OF THE AURAL ANGLE OF ATTACK/STALL WARNING SYSTEM Penn Evans Mullowney, Jr. Jun. 1973 90 p refs (AD-767663) Avail: NTIS CSCL 01/2

Maximum performance and stall avoidance can be realized in high-performance aircraft only if the pilot is fully aware of angle of attack. Because present methods of providing this information have proven to be inadequate, an alternative method has been proposed. The paper describes an electronic device providing angle of attack.

N74-13749# Air Force Academy, Colo. Dept. of Aeronautics. A PYLON TO DECREASE THE EFFECTS OF EXTERNAL STORES ON THE STABILITY OF AIRCRAFT Final Report Edgar W. Lorson and Lawrence E. Day Jul. 1973 51 p refs (AD-767913: DFAN-TR-73-5) Avail: NTIS CSCL 01/3

A series of wind tunnel studies were accomplished at the USAFA to determine the effect of a new low side area pylon on the static longitudinal stability of aircraft carrying external stores. Several configurations of MK 82 and M 117 bombs on triple ejection racks and multiple ejection racks were run at Mach numbers of .2, .82 and .91. The static margins for similar bomb configurations on inventory type pylons and new low side area pylons are compared. For the tests at M .2 the loss in static margin for a given configuration on the new low side area pylon was an average of 19% less than that on an inventory type pylon. The average loss in static margin for the transonic runs with the inventory pylon was 8.9% mean aerodynamic chord (MAC) while the same configurations with the new pylon gained an average of 2.2% mean aerodynamic chord (MAC).

Author (GRA)

N74-13750# Air Force Academy, Colo. Dept. of Aeronautics. A COMPUTER PROGRAM FOR AIRCRAFT OPTIMAL CONTROL PROBLEMS

Jerry D. Hines and Juane M. Davis Jul. 1973 117 p. refs (AD-767919; DFAN-TR-73-4) Avail: NTIS CSCL 01/3

The report described uses a gradient technique having a rapid convergence rate to investigate problems of aircraft optimal control. The FORTRAN program for the Burroughs 6700 computer and sample output are included for a minimum time turn (3 dimensional) for an aircraft with thrust vectoring capability. The operation of the program is explained and the program variables Author (GRA) are identified.

N74-13751# Center for Naval Analyses, Arlington, Va. AIRCRAFT FORCE PROTECTION MODEL VOLUME 1: USERS GUIDE TO AFPM

Steven W. Klein and Thomas H. Thoureen Mar. 1973 151 p refs

(Contract N00014-68-A-0091)

(AD-767946: CNA-Res-Contrib-225) Avail: NTIS CSCL 15/5 The Aircraft Force Projection Model (AFPM) is a FORTRAN. model which projects the Navy's aircraft inventory over a ten-year period and attempts to satisfy the operating requirements of a given set of forces with the projected operating inventory. This comparison of operating inventory and force requirements is the characteristic which sets the AFPM apart from most inventory projection models. The AFPM generates useful characteristics of the aircraft inventory such as projections of the age distribution, attrition quantities, pipeline requirements and rework Author (GRA) requirements.

N74-13752# Environmental Protection Agency, Washington, D.C. Office of Noise Ablatement and Control. MILITARY AIRCRAFT AND AIRPORT NOISE AND OF PORTUNITIES FOR REDUCTION WITHOUT INHIBITION OF MILITARY MISSIONS Final Report

Sidney Nethery 27 Jul. 1973 187 p refs (PB-223637/0GA) Avail: NTIS HC \$5.25 CSCL 01C

The report is a result of an extensive task force effort to gather all available data pertinent to military aircraft and airport noise and opportunities for reduction without inhibition of military missions. It represents the interpretation of such data by the task group chairman responsible for this specific report.

N74-13753# Naval Postgraduate School, Monterey, Calif. Dept. of Electrical Engineering. TURNING CHARACTERISTICS OF THE BELL 100 TON

SURFACE EFFECT SHIP M.S. Thesis Kenneth Randall Myers Jun. 1973 145 p

(AD-767680) Avail: NTIS CSCL 13/10

The turning characteristics of the Bell 100 ton captured Air Bubble Surface Effect Ship (CAB/SES) are studied with the aid of the Oceanic Incorporated computer simulation. The crafts motions for straight runs, straight runs with waves and turning runs under calm water conditions, are compared with the final set of computer simulation turning maneuvers with waves involving changing speeds, wavelengths, wave amplitudes, and final rudder Author (GRA) angles.

N74-13754# Rockwell International Corp., Los Angeles Calif. STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY

BLOWN FLAP. VOLUME 1: CONFIGURATION DEFINITION. SUPPLEMENT 1: AERODYNAMIC TRADES OF FLAP AND ROLL CONTROL SYSTEM Final Report, 10 Jun. 1971 -10 Dec. 1972

Dirk J. Renselaer Wright-Patterson AFB, Ohio AFFDL Apr. 1973 122 p refs 6 Vol.

(Contract F33615-71-C-1760; AF Proj. 643A) (AD-767179; AFFDL-TR-73-20-Vol-1-Suppl-1) Avail: NTIS CSCL 01/3

Contents: Comparison of climb speeds; Comparison of roll acceleration with all engines operating; Comparison of roll acceleration with one engine inoperative; Comparison of lift loss due to maximum roll control.

N74-13755# Rockwell-International Corp., Los Angeles Calif. Aircraft Div

STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP. VOLUME 3: PERFORMANCE METHODS AND LANDING RULES Final Report, 10 Jun. 1971 - 10 Dec.

Dirk J. Renselaer Wright-Patterson AFB, Ohio AFFDL Apr. 1973 161 p refs 6 Vol. (Contract F33615-71-C-1760; AF Proj. 643A)

(AD-767180; AFFDL-TR-73-20-Vol-3) Avail: NTIS CSCL 01/3

Contents: Identification of critical STOL safety aspects; Recommended ground rules, STOL takeoff performance; STOL landing performance

N74-13756# Rockwell International Corp., Los Angeles Calif.

STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP. VOLUME 5, PART 1: CONTROL SYSTEM MECHANIZATION TRADE STUDIES Final Report, 10 Jun. 1971 - 10 Dec. 1972

Robert W. Phillips Wright-Patterson AFB, Ohio AFFDL Apr. 1973 70 p refs 6 Vol. (Contract F33615-71-C-1760; AF Proj. 643A)

(AD-767181; AFFDL-TR-73-20-Vol-5-Pt-1) Avail: NTIS CSCL 01/3

Contents: System analyses: System characteristics comparison; Control component requirements: Handling qualities. GRA

N74-13757# Rockwell International Corp., Los Angeles Calif. Aircraft Div

STOL TACTICAL AIRCRAFT INVESTIGATION, EXTERNALLY BLOWN FLAP, VOLUME 5, PART 3: STABILITY AND CONTROL DERIVATIVE ACCURACY REQUIREMENTS AND EFFECTS OF AUGMENTATION SYSTEM DESIGN Final Report, 10 Jun. 1971 - 10 Dec. 1972

Victor H. Kumoto and William K. Elsanker Wright-Patterson AFB, Ohio AFFDL Apr. 1973 201 p refs 6 Vol.

(Contract F33615-71-C-1760; AF Proj. 643A)

(AD-767182; AFFDL-TR-73-20-Vol-5-Pt-3) Avail: NTIS CSCL 01/3

Contents: Flying qualities requirements: Selection of baseline flight condition; Selection of coefficient variation ranges; Technical approach; Coefficient prediction accuracy requirements; Lateraldirectional parameter variation data; Longitudinal parameter variation data; Coefficient accuracy requirements -- unaugmented aircraft; Coefficient accuracy requirements -- baseline augmented aircraft. GRA

N74-13882* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A REAL-TIME DIGITAL PROGRAM FOR ESTIMATING AIRCRAFT STABILITY AND CONTROL PARAMETERS FROM FLIGHT TEST DATA BY USING THE MAXIMUM LIKELIHOOD METHOD

Randall D. Grove and Stanley C. Mayhew (Electronic Assoc., Inc.) Washington Dec. 1973 132 p refs (NASA-TM-X-2788; L-8796) Avail: NTIS HC \$4.50 CSCL

09B

A computer program (Langley program C1123) has been developed for estimating aircraft stability and control parameters from flight test data. These parameters are estimated by the maximum likelihood estimation procedure implemented on a real-time digital simulation system, which uses the Control Data 6600 computer. This system allows the investigator to interact with the program in order to obtain satisfactory results. Part of this system, the control and display capabilities, is described for this program. This report also describes the computer program

by presenting the program variables, subroutines, flow charts. listings, and operational features. Program usage is demonstrated with a test case using pseudo or simulated flight data:

N74-13903# Westinghouse Electric Corp., Lima, Ohio. Aerospace

THE ac POWER CONTROLLERS FOR SOLID STATE DISTRIBUTION SYSTEM. VOLUME 1: DESIGN, DEVELOP-MENT, FABRICATION, AND TEST OF HYBRID DEVICES Final Report, Jun. 1971 - May 1973

James T. Mitchell, W. W. Billings, K. C. Shuey, and C. M. Gauthier Sep. 1973 162 p

(Contract F33615-71-C-1900; AF Proj. 3145)

(AD-768199; WAED-73-12-Vol-1; AFAPL-TR-73-75-Vol-1)

Avail: NTIS CSCL 09/3

The report describes the work done in a program in which solid state power controllers were designed, developed, fabricated. and tested. Units rated 1.0 through 5.0 amperes, 230 volts. and 1.0 through 75 amperes, 115 volts, 400 Hz, were built using hybrid thick-film bare chip and wire techniques. Details of the test results, circuit designs, and recommendations are included as part of this report Author (GRA)

N74-13954# Army Transportation Engineering Agency, Newport News, Va.

RESTRAINT PROCEDURES FOR CARGO LOADED IN VEHICLES TO BE AIR TRANSPORTED

Louis Zabohonski, Jr. Aug. 1973 46 p.

(AD-768172; USATEA-73-23) Avail: NTIS CSCL 13/6

The report covers an analysis of the strength of the side racks of Army tactical cargo vehicles to determine their suitability to restrain cargo during air transport. The shear strength of the attachment of the cargo bed to the frame is defined based on information furnished from the US Army Tank-Automotive Command (USATACOM). Outlined are procedures for properly loading and restraining cargo in vehicles, using commonly available material. Results of the report indicate that the cargo bed shear from the frame and that these loads can be adequately restrained to the vehicle. The report also reveals potential problems in analyzing aircraft floor loads when the cargo is a loaded vehicle Author (GRA)

N74-13957# Braun (C. F.) and Co., Alhambra, Calif. TURBOJET AIRCRAFT ENGINE TEST CELL POLLUTION ABATEMENT STUDY Final Report, Jul. - Dec. 1972 George F. Davies and Richard H. Crow 29 Jun. 1973 96 p refs

(Contract N62399-72-C-0020)

(AD-768287; NCEL-CR-74.001) Avail: NTIS CSCL 21/5

The report summarizes the results of a survey and analysis of the application of conventional air pollutant abatement systems to the exhaust gas from jet engine test cells. The following methods for gas treatment were investigated: wet scrubbers, incinerators, electrostatic precipitators, filters, dry inertial collectors. The least costly methods for meeting present emission standards are water scrubbing systems. One of the most attractive of wet scrubbers using Koch Flexitrays is developed in detail. The report covers the associated problem of water supply and disposal. The report also includes research and development suggestions for test cell emission control. Author (GRA)

N74-13960 New York Univ., N.Y.

THREE-DIMENSIONAL COMPRESSIBLE BOUNDARY LAYER FLOW OVER A YAWED CONE WITH MASS INJECTION Ph.D. Thesis

Ohyun Rho 1973 191 p

Avail: Univ. Microfilms Order No. 73-19402

. An analytical scheme called the method of multi-interval expansions was introduced to solve the equations of the three-dimensional boundary layer flow. In multi-interval expansions, the solutions of the boundary layer equations in the interval are expressed in terms of those of the previous interval in such a way that all the physical properties and the relevant differential equations are continuous at the boundary between intervals. Consequently, the solutions for the whole flow field are obtained if the solutions of the first interval have been obtained. The first interval can be chosen, in general, as any region of the flow field. However, it may be preferably chosen as a domain, if possible, of the flow field where the governing differential equations are simplified in view of the nature of the flow field at that particular domain, for example, the plane of symmetry Dissert. Abstr. of a yawed cone.

N74-13992# ARO, Inc., Arnold Air Force Station, Tenn. CALCULATION OF THE BOUNDARY-LAYER FLOW IN THE WINDWARD SYMMETRY PLANE OF A SPHERICALLY BLUNTED AXISYMMETRIC BODY AT ANGLE OF ATTACK. INCLUDING STREAM LINE-SWALLOWING EFFECTS Final Report, Sep. 1971 - Dec. 1972

Arloe W. Mayne, Jr. AEDC Oct. 1973 57 p refs (ARO Proj. VW5206; ARO Proj. VF203)

(AD-768340: ARO-VKF-TR-73-102; AEDC-TR-73-166) Avail: NTIS CSCL 20/4

Three-dimensional compressible boundary-layer equations are particularized to the windward symmetry plane of a spherically blunted axisymmetric body at incidence under hypersonic conditions. Through the use eddy transport and streamwise intermittency both transitional and fully turbulent boundary layers may be treated. A scheme is presented for determining the outer-edge boundary conditions based on a mass flow balance treatment of the boundary-layer entrainment of the inviscid flow. A finite-difference technique is described for solving the set of partial differential equation governing the boundary-layer flow, and for treating the streamline-swallowing phenomenon.

N74-14119# Sandia Labs., Albuquerque, N.Mex. Signal Analysis

AIRCRAFT VELOCITY MEASUREMENT THROUGH RADAR-ALTIMETER ECHO: A THEORETICAL INVESTIGATION Charles S. Williams Jul. 1973 36 p refs Sponsored by AEC (SLA-73-669) Avail: NTIS HC \$4.00

An examination of the character of the fading of the echo of a radar altimeter indicates that it might be used to obtain aircraft velocity with considerable accuracy. This preliminary examination considers neither the hardware problems nor the problems that an extremely rough terrain might cause.

Author (NSA)

N74-14126# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

AN INVESTIGATION OF PATTERN RECOGNITION OF AIRCRAFT ATTITUDES INDICATOR DISPLAYS M.S. Thesis

Robert Parker Bateman Jun. 1973 54 p refs (AD-768345; GA/EE/73-3) Avail: NTIS CSCL 01/4

Spatial disorientation accident statistics are reviewed, along with unsuccessful attempts to prevent these aircraft accidents. The lack of a theoretical basis for flight instrument design is noted. A systems approach to the problem is proposed, which requires a knowledge of the human visual system. It is suggested that attitude indicator displays, the interface between man and machine, should be designed to be compatible with an internal model of spatial position. Orientation in space by the use of flight instruments is identified as a pattern recognition problem. A Fourier transform model of the human visual system is used to evaluate and classify attitude indicator displays. An algorithm is proposed for separating patterns. (Modified author abstract)

N74-14138*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

IMPROVED CIRCUMFERENTIAL SHAFT SEAL FOR

AIRCRAFT GEAR TRANSMISSIONS

Lawrence P. Ludwig and Thomas N. Strom Washington Dec. 1973 14 p

(NASA-TN-D-7130; E-7133) Avail: NTIS HC \$2.75 CSCL

Operation under simulated aircraft transmission conditions of speeds to 2850 m/min (9350 ft/min), lubricant temperatures to 394 K (250 F), shaft radial runouts to 0.254 mm (0.010 in.) F.I.R. (full indicator reading), and pressure differentials to 1.03 N/cm2 (1.5 psi) revealed that conventional circumferential seals leaked excessively. Modifying the conventional seal by adding helical grooves to the seal bore reduced leakage rates to within the acceptable level of 10 cm3/hr. The leakage rate of this modified seal was not significantly affected by lubricant flooding or by shaft radial runout.

N74-14238# General Dynamics/Fort Worth, Tex. Convair Aerospace Div.

STUDY OF STRUCTURAL CRITERIA FOR COMPOSITE AIRFRAMES, VOLUME 1: EVALUATION Final Technical Report

Sherrill D. Manning and Glen H. Lemon Wright-Patterson AFB. Ohio AFFDL Apr. 1973 248 p refs 3 Vol.

(Contract F33615-72-C-1066)

(AD-767706; AFFDL-TR-73-4-Vol-1) Avail: NTIS CSCL 11/4 Criteria and design practices currently used for aircraft structures are examined and evaluated for applicability to composite structures. Selected probabilistic or statistical rationales are also reviewed and evaluated for possible applications. From these studies a plan was developed for acquiring understanding and data from which structural criteria and design practices applicable to composite airframes may be written. The basic characteristics of filamentary composites that are unique in comparison to those of metals are defined and explored. Special areas investigated include laminates, joints, and cutouts. (Modified author abstract)

N74-14239# General Dynamics/Fort Worth, Tex. Aerospace Div.

STUDY OF STRUCTURAL CRITERIA FOR COMPOSITE CURRENT/CRITERIA/ VOLUME 2: AIRFRAMES. SELECTED RATIONALE REVIEW AND EVALUATION Final Techinical Report

Sherrill D. Manning, Glen H. Lemon, and Innes Bouton Wright Patterson AFB, Ohio AFFDL Apr. 1973 227 p refs 3 Vol.

(Contract F33615-72-C-1066)

(AD-767707; AFFDL-TR-73-4-Vol-2) Avail: NTIS CSCL 11/4 Criteria and design practices currently used for aircraft structures are examined and evaluated for applicability to composite structures. Selected probabilistic or statistical rationales are also reviewed and evaluated for possible applications. From these studies a plan was developed for acquiring understanding and data from which structural criteria and design practices applicable to composite airframes may be written. The basic characteristics of filamentary composites that are unique in comparison to those of metals are defined and explored. Special areas investigated include laminates, joints, and cutouts. The structural criteria derived from metallic structure experiences are not applicable to composite structure because the critical interaction of a low strain to failure material with structural complexity is not recognized; universal requirements and rigid design practices irrespective of material, design concept or manufacturing methods, or size effects are imposed, and an assumption of translation of residual strength and lifetime allowables from the material level to the component level, which is incompatible with observed composite behavior is imposed. Accelerated test procedures have not been developed successfully; therefore, near-term composite designs should be developed using a realistic random load and environment simulation, in order to achieve the necessary confidence in structural integrity, the composite design should acknowledge fleet size, reliability goals, structural complexity, scaling from test specimen-to-component level. (Modified author abstract)

N74-14246# Air Force Materials Lab., Wright-Patterson AFB. Ohio

IMPROVED SILICONE FLUIDS AS CANDIDATE GAS TURBINE ENGINE OILS FOR MINUS 40 F TO 465 F TEMPERATURE RANGE Technical Report, Nov. 1971 - Jul.

George J. Morris Jul. 1973 29 p. refs (AF Proj. 7345)

(AD-767898; AFML-TR-73-72) Avail: NTIS CSCL 11/8

A physical and chemical laboratory study of several silicone fluids that represent some of the latest technology in the area has been conducted. These fluids were an alkyl methyl silicone, a trifluoropropyl methyl silicone and a methyl silicone improved by the use of additive formulation. These fluids were investigated for possible use as candidate gas turbine engine oils in the temperature range of -40F to -465F. The viscosity-temperature characteristics, volatility, oxidation stability, corrosion reactivity towards selected metals and lubrication capabilities were assessed for conformance with the recently established specification. MIL-L-27502, covering the aforementioned temperature range. The alkyl methyl silicone, although having favorable rheological and lubrication behavior, was so exidatively unstable and corresion prone that further study is not recommended. Both trifluoropropyl methyl silicone and improved methyl silicone have demonstrated sufficient oxidation and corrosion stability to warrant further GRA

N74-14271# Advisory Group for Aerospace Research and Development, Paris (France).

ATMOSPHERIC POLLUTION BY AIRCRAFT ENGINES Sep. 1973 405 p refs Mostly in ENGLISH; partly in FRENCH Conf. held at London, 9-13 Apr. 1973 (AGARD-CP-125) Avail: NTIS HC \$22.25

The proceedings of a conference on the effects of aircraft engines on atmospheric pollution are presented. The impact of military and civilian aircraft operations on pollution levels are compared with the pollution from other sources. The subjects stressed are: (1) effects of pollution at very high eltitudes, (2) effects of pollution near airports, and (3) methods for reduction of pollutant production in combustion processes and in engines. A review of the physiological effects of air pollution is included.

N74-14272* New York Univ., N.Y. Dept. of Aeronautics and

REDUCTION OF NO FORMATIONS BY PREMIXING

Antonio Ferri In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 10 p ref

(Grant NGR-33-016-131)

The effects of exhaust gases from supersonic transport aircraft on the equilibrium of the stratosphere are discussed. A method for reducing the amount of nitrogen oxides generated by the engines of supersonic transports is describes. The engine requirements for the turbojet engines of the supersonic transport aircraft are defined. The design of combustion chambers to provide premixed flames and the thermodynamic properties of premixed flames are analyzed. Charts are developed to show the isotherms of the ignited mixtures for various conditions and the mass fraction of nitrogen oxide along selected streamlines.

N74-14273 Department of Transportation, Washington, D.C. UNITED STATES DEPARTMENT OF TRANSPORTATION RESEARCH PROGRAM FOR HIGH ALTITUDE POLLUTION Alan J. Grobecker In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p refs

A review of a United States program to provide an assessment by 1974 of the impact on man, plants and animals of climatic changes due to perturbations of the upper atmosphere by the propulsion effluents of a world high-altitude aircraft fleet as projected to 1990 is presented. Some physical considerations which must be taken into account in this program are described, including representations: of the stratosphere in its unperturbed state, of the effluents of vehicles expected in 1990. of the perturbed stratosphere of 1990, of the perturbed

troposphere of 1990 and 2020, of the effects of climatic changes on the biosphere and of social and economic measures of these biological effects Author

N74-14277 Bonn Univ. (West Germany). Inst. fuer Physikalische Chemie

PHOTO-OXIDATION OF AIRCRAFT ENGINE EMISSIONS AT LOW AND HIGH ALTITUDES

K. H. Becker and U. Schurath In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 9 p. refs.

The mechanism of photochemical simog formation is examined. The applicability of photochemical smog formation to aircraft emissions is described. It is concluded that photo-exidation mechanisms of pollutants from aircraft and other sources in the troposphere undergo fundamental changes with altitude, radical and atom reactions, and probably reactions of metastable oxygen molecules, becoming more important in the colder regions of the troposphere. Serious contamination of the troposphere by aircraft is not expected, because the residence time of pollutants is short compared with emissions rates. Author

N74-14278 Oslo Univ. (Norway). Inst. of Geophysics. EFFECT OF SUPERSONIC TRANSPORT UPON THE OZONE LAYER, STUDIED IN A TWO-DIMENSIONAL PHOTOCHEMI-CAL MODEL WITH TRANSPORT

Eigil Hesstvedt In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 8 p refs

A steady state two-dimensional model of the stratospheric ozone layer is presented. Photochemical reactions involving oxygen, hydrogen, and nitrogen are considered along with the effect of a parameterized, two-dimonsional transport, by mean motion and by eddies. A parameterized meridional distribution of NOx is applied, computed from one-dimensional models. The model is in fair agreement with observed ozone data. The reduction of azone from emission of NOx from supersonic aircraft is studied. assuming a fleet of 200 aircraft, flying at given altitudes and uniformly distributed over the globe. The effect is found to depend critically upon the flight level. For mid-latitude, summer, the ozone column density is reduced by 0.4% for a flight level of 18 km. For flight levels 23 km and 28 km the reduction is 1.6% and 2.3%, respectively. Accordingly, the increase in UV-radiation amounts to approximately 0.8%, 3.2%, and 4.6% for the same flight levels.

N74-14281 Bristol Univ. (England). Dept. of Aeronautical Engineering

PROBLEMS OF CHEMICAL POLLUTION BY AIRCRAFT. THE AIRPORT AND ITS IMMEDIATE ENVIRONMENT

T. V. Lawson In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 3 p

The chemical pollution of the airport and its environment is discussed. It calls for a careful study of all surveys so that the inbuilt implications of the model are obvious, and it concludes that the problems of chemical pollution by the aircraft themselves are small. It suggests that much more progress will be made, in attempts to reduce pollution around airports by concentrating upon organizations other than the engine manufacturers. It closes by suggesting that authors of technical papers be encouraged to supply an epilogue in which they summarize the findings of their work for the benefit of the lay public.

N74-14282 Warren Spring Lab., Stevenage (England). Pollution Div.

RELATIVE AIR POLLUTION EMISSIONS FROM AN AIRPORT IN THE UK AND NEIGHBOURING URBAN AREAS

A. W. C. Keddie, J. Parker, and G. H. Roberts. In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 9 p

Air pollution levels at Stansted Airport in relation to emissions from four nearby towns are discussed. Calculations have been made of pollution emissions from these four sources and also from the airport and the expected contributions from these sources at three local sites have been examined. These values are compared with actual measurements at the three sites. Author

N74-14283 Chemical Defence Experimental Establishment. Porton (England). GROUND CONTAMINATION BY FUEL JETTISONED FROM

AIRCRAFT N. L. Cross and R. G. Picknett IN AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 9 p refs

A study of the problem of ground pollution produced by fuel jettisoned from aircraft under emergency conditions was conducted. The likely size distribution of drops produced when fuel is jettisoned is examined. The proportions of jettisoned fuel which survive evaporation to reach the ground are determined. It is stated that the contamination density on the ground depends on atmospheric stability, wind speed, and direction of flight relative to wind direction. Data obtained from flight tests of jettisoned fuel are presented in tables and graphs.

N74-14284 Air Corporations Joint Medical Service (BEA/BOAC). London (England).

POLLUTION LEVELS AT LONDON (HEATHROW) AIRPORT AND METHODS FOR REDUCING THEM

D. M. Bruton In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 6 p. ref

Exhaust pollution levels at Heathrow Airport, London, England were conducted. Medical surveys of the interior of buildings were conducted to determine pollution levels. It was determined that pollution levels are below those of many urban areas and do not appear to represent either a short or long range hazard to health, Local pollution problems constitute a source of annoyance to ground personnel employed at the airport. Methods for reducing the exhaust fume emission by vehicle selection, engine tuning, and maintenance practices are recommended.

N74-14285 Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.

POLLUTION CONTROL OF AIRPORT ENGINE TEST FACILITIES

D. L. Baily, P. W. Tower, and A. E. Fuhs In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 32 p refs

Engine test facilities are required to meet the same environmental standards as any other industrial facility. To meet the standards for smoke, noise, gaseous pollutants, etc. control equipment must be installed. Due to large mass flow rates the control equipment is expensive, careful attention to design is necessary to control costs. Pollution control forces new constraints on exhaust stack temperature, flow uniformity and pressure. Conversely, installation of pollution abatement apparatus may cause adverse operating conditions such as distorted flow into the engine and wrong augmentation ratio. The internal aerodynamics of engine test cells must be mastered to a level not possible previously. Scale models of test cells were fabricated in modules so that some 750 different combinations could be tested. Distortion at the engine face was measured and correlated in terms of component factors. Augmentation ratio and cell depression were measured. An analytical model correctly predicted the measured quantities except for distance from engine nozzle to augmenter inlet. With the data accumulated it should be possible to match pollution control requirements to test cell narameters.

N74-14291* Massachusetts Inst. of Tech., Cambridge Dept. of Mechanical Engineering. PARAMETERS CONTROLLING NITRIC OXIDE EMISSIONS FROM GAS TURBINE COMBUSTORS John B. Heywood and Thomas Mikus In AGARD Atmospheric

Pollution by Aircraft Engines Sep. 1973 16 p refs

(Grant NGR-22-009-378)

Nitric oxide forms in the primary zone of gas turbine combustors where the burnt gas composition is close to stoichiometric and gas temperatures are highest. It was found that combustor air inlet conditions, mean primary zone fuel-air ratio, residence time, and the uniformity of the primary zone are the most important variables affecting nitric oxide emissions. Relatively simple models of the flow in a gas turbine combustor, coupled with a rate equation for nitric oxide formation via the Zeldovich mechanism are shown to correlate the variation in measured NOx emissions. Data from a number of different combustor concepts are analyzed and shown to be in reasonable agreement with predictions. The NOx formation model is used to assess the extent to which an advanced combustor concept. the NASA swirt can, has produced a lean well-mixed primary zone generally believed to be the best low NOx emissions burner tyne.

N74-14292 California Univ., Berkeley. Dept. of Mechanical Engineering. FACTORS CONTROLLING POLLUTANT EMISSIONS FROM

GAS TURBINE ENGINES

R. F. Sawyer, N. P. Cernansky, and A. K. Oppenheim In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p refe

(Grants AF-AFOSR-2299-72; AF-AFOSR-2200-72)

Primary pollutants emitted by aircraft gas turbine engines are carbon monoxide, hydrocarbons, aldehydes, smoke, particulates, and nitric oxide. Factors controlling emissions of these pollutants are analyzed on the basis of aircraft engine exhaust composition and laboratory studies of gas turbine combustion processes. Moreover, an analytical prediction of the effect of aircraft operating parameters on the emission of nitric oxide is also given. The formation and destruction of these pollutants were investigated in a laboratory gas turbine combustor. The oxidation of carbon monoxide, hydrocarbons, and aldehydes was measured in the dilution zone where thermal quench phenomena were observed. The apparent oxidation of particulates in the dilution zone was also observed. The formation of nitric oxide was observed in the primary zone and in the first part of the dilution section of the combustor. Operational conditions and engine parameters were studied analytically, yielding rational criteria for the prediction of their effect on the emmission of Author nitric oxide.

N74-14293 Norwegian Inst. for Air Research, Kjeller. A SYSTEMATIC APPROACH TO THE STUDY OF THE CONNECTION BETWEEN EMISSION AND AMBIENT AIR CONCENTRATIONS

Knut Erik Groenskei In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 10 p refs

A systematic approach to study the effect of a complex source distribution on the ambient air quality is described. Measurements of emission, meteorological parameters, and ambient air concentrations are used to develop a quantitative model describing the important physical and chemical processes. The model is mathematically formulated in a modified form of the continuity equation for the pollution component. To improve the model, regression analysis can be used. An example of this approach is given in the study of air pollution in Oslo where it has been shown that a systematic vertical motion is the most important process to clean the air in Oslo during inversion situations. Some comments are made on the model approach to the air pollution problem around an airfield. Author

N74-14300 General Electric Co., Cincinnati, Ohio. Advanced Combustion and Emissions Control Technology. TECHNOLOGY FOR THE REDUCTION OF AIRCRAFT TURBINE ENGINE EXHAUST EMISSIONS Donald W. Bahr In AGARD Atmospheric Pollution by Aircraft

Engines Sep. 1973 13 p refs

Tests of both production and advanced engines were conducted to determine the emission characteristics of aircraft turbine engines. The results of these engine evaluations are presented. Also presented are the results of exploratory investigations to define and develop design approaches for reducing the carbon monoxide, unburned hydrocarbons, and nitrogen oxides emission levels of high performance, annular combustors - with already developed low smoke emission characteristics. In these latter investigations, the emissions level reductions obtainable through the use of advanced primary combustion zone stoichiometry control methods and advanced fuel injection techniques were evaluated. In addition, results are presented on the use of water injection techniques to suppress the formation of nitrogen oxides in combustors. It is concluded that future engines can be developed with significantly lower levels of these gaseous emissions than those of current engines.

N74-14301 Cranfield Inst. of Technology (England). School of Mechanical Engineering.

A PRELIMINARY STUDY ON THE INFLUENCE OF FUEL STAGING ON NITRIC OXIDE EMISSIONS FROM GAS TURBINE COMBUSTORS

A. H. Lefebvre and R. S. Fletcher In AGARD Atmospheric Pollution by Aircraft Engines Sep. 1973 7 p. refs

The results are presented from a preliminary investigation carried out on a tubular aircraft combustor chamber which was perfectly standard apart from an additional fuel injector located just downstream of the primary zone. Measurements of nitric oxide exhaust emissions were carried out over a range of fuel to both primary and secondary zones and the results compared with predictions based on a praviously derived mathematical model.

N74-14302* National Aeronautics and Space Administration. Lewis Research Center, Cloveland, Ohio.

DESIGN AND EVALUATION OF COMBUSTORS FOR REDUCING AIRCRAFT ENGINE POLLUTION

Robert E. Jones and Jack Grobman In AGARD Atmospheric Pollution by Aircraft Engine Sep. 1973 8 p. refs

Various techniques and test results are briefly described and referenced for detail. The effort arises from the increasing concern for the measurement and control of emissions from gas turbine engines. The greater part of this research is focused on reducing the oxides of nitrogen formed during takeoff and cruise in both advanced CTOL, high pressure ratio engines, and advanced supersonic aircraft engines. The experimental approaches taken to reduce oxides of nitrogen emissions include the use of: multizone combustors incorporating reduced dwell time, fuel-air premixing, air atomization, fuel prevaporization, water injection, and gaseous fuels. In the experiments conducted to date, some of these techniques were more successful than others in reducing oxides of nitrogen emissions. Tests are being conducted on full-annular combustors at pressures up to 6 atmospheres and on combustor segments at pressures up to 30 atmospheres.

Author

N74-14304 Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

AIRCRAFT GAS TURBINE POLLUTANT LIMITATIONS ORIENTED TOWARD MINIMUM EFFECT ON ENGINE PERFORMANCE

Atmospheric Pollution by Aircraft Engines Sep. 1973 13 p

The proposed Environmental Protection Agency (EPA) regulations for aircraft engine emissions are examined in terms of their impact on the application to military aircraft gas turbine engines. A quantitative assessment of current engine emission levels, design trends, and potential emission control techniques is presented. It is concluded that special considerations must be afforded to military aircraft relative to direct application of EPA regulations; however, many future emission—reducing advances will be applicable to military gas turbines. U. S. Air Force goals were established to insure that new engines take advantage of

this technology, and are in accordance, to the greatest degree possible, with what EPA requires of commercial aircraft. These goals are in terms of minimum idle combustion inefficiency, maximum allowable oxides of nitrogen (lb/1000 lb-fuel), and maximum allowable smoke number. The rationale behind using these parameters, and the means by which the numerical limitations were derived, are described.

N74-14340# Airborne Instruments Lab., Deer Park, N.Y. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 1.0, VOLUME 1.1: TECHNIQUE ANALYSIS PROGRAM Washington FAA 27 Sep. 1972 347 p refs (Contract DOT-FA72WA-2800) (FAA-RD-73-166-Vol-1.1) Avail: NTIS HC \$19.50

The development plan for a microwave landing system is analyzed. The subjects investigated are: (1) system functional requirements, (2) signal format and hardware characteristics, (3) compatibility of proposed system with existing landing systems and aircraft equipment, (4) critical technical areas, and (5) special component development requirements. The objective of the study is to prove feasibility of the concept and to show that the system will be practical and cost effective.

N74-14341# Airborne Instruments Lab., Deer Park, N.Y. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 1.0, VOLUME 1.2, BOOK 1: POST TACD DEVELOPMENT PLAN

Washington FAA 27 Sep. 1972 433 p refs (Contract DOT-FA72WA-2800) (FAA-RD-73-166-Vol-1.2,1-Bk-1) Avail: NTIS HC \$23.75

The test program for evaluation of a microwave landing system is presented. The purpose of the plan is to confirm that the system has the capability of meeting specified functional and operational requirements. The tests which are considered necessary to evalute the performance of the system are defined. The test methods, including flight test phases, are explained. The phases, equipment tested, test objectives, and test facilities are tabulated.

N74-14342# Airborne Instruments Lab., Deer Park, N.Y. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 1.0, VOLUME 1.2, BOOK 2: POST TACD DEVELOPMENT PLAN

Washington FAA 27 Sep. 1972 372 p refs (Contract DOT-FA72WA-2800)

(FAA-RD-73-166-Vol-1.2,2-8k-2) Avail: NTIS HC \$20.75

The various configurations of the microwave landing system are discussed. The variations are developed from the requirements of the organizations using the system. Each variation of the microwave landing system is described in terms of: (1) functional characteristics, (2) azimuth guidance equipment, (3) elevation guidance equipment, (4) distance measuring equipment, and (5) airborne equipment. Circuit diagrams of the electronic components of the system are provided.

N74-14343# Airborne Instruments Lab., Deer Park, N.Y. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 3.0, VOLUME 3.1, BOOK 1: COMPILATION OF CRITICAL TECHNICAL AREA REPORTS

Washington FAA 27 Sep. 1972 346 p refs (Contract DOT-FA72WA-2800)

(FAA-RD-73-166-Vol-3.1,1-Bk-1) Avail: NTIS HC \$19.50

. The critical technical areas (CTA) involved in the development of a microwave landing system are presented. The CTA's discussed are: (1) curved path utilization, (2) air traffic control interface. (3) auxiliary data utilization, (4) back course utilization, (5) missed approach transition, (6) airborne antennas, and (7) azimuth side lobe suppression.

N74-14344# Airborne Instruments Lab., Deer Park, N.Y. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY AIL DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PROGRAM. PART 3.0, VOLUME 3:1, BOOK 2: COMPILATION OF CRITICAL TECHNICAL AREA REPORTS

Washington FAA 27 Sep. 1972 351 p refs

(Contract DOT-FA72WA-2800)

(FAA-RD-73-166-Vol-3.1,2-Bk-2) Avail: NTIS HC \$19.75

The critical technical areas (CTA) involved in the development of a microwave landing system are presented. The CTA's discussed are: (1) auxiliary data recovery, (2) auxiliary data interpretation. (3) channel pairing, (4) receiver spurious response analysis, (5) decoder class compatibility, (6) distance measuring equipment, and (7) signal attenuation.

N74-14352 Royal Aircraft Establishment, Farnborough (Eng-

AIRCRAFT INERTIAL SYSTEM TESTING AND EVALUATION IN THE UNITED KINGDOM

R. F. Stokes and S. G. Smith In AGARD Testing Philosophy and Methods of Guidance and Control Systems and Subsystems Oct. 1973 49 p

Internal system testing by Government Departments in the United Kingdom is undertaken by two Establishments - RAE Farnborough and A and AEE Boscombe Down. For historical reasons most flying is done at A and AEE, where a fully instrumented aircraft has been provided for precise navigation trials, but the methods used are largely derived at RAE. Details of the reference equipment available, its advantages and drawbacks, are given, together with a description of the methods used to obtain a high quality, world-wide position and velocity reference. Various methods of obtaining statistical performance parameters are discussed and their consistency is demonstrated. The problems of performance diagnosis are illustrated with a worked example, which also shows the use of a digital mathematical model of an IN system. Some ideas on a possible new approach to inertial system testing are also given. Author

N74-14360# National Aviation Facilities Experimental Center, Atlantic City, N.J.

FIELD EVALUATION OF ARTS 2 B (TRACAB) Interim Report, Feb. - Apr. 1973

Robert A. Clark and James F. Akers Oct. 1973 50 p refs (AD-768203: FAA-NA-73-54: FAA-RD-73-119) Avail: NTIS CSCL 17/7

A programmable ARTS (Automated Radar Terminal System) 11 B, non-tracking, beacon alphanumeric system was installed in a TRACAB (Terminal Radar Approach Control Cab) configuration in a live air traffic control tower environment. Operational suitability and techniques to be used in the automation program for low-density terminal/towers were evaluated. The system was evaluated over a six-week period through collection of subjective data obtained from controller questionnaires. It was concluded that while suitable for application in a TRACAB (Terminal Radar Approach Control Cab) environment and compatible with the controller, extensive modification to both display subsystem and software were required to improve its Author (GRA) usefulness.

N74-14361# Transportation Systems Center, Cambridge, USER'S MANUAL FOR ILSLOC: SIMULATION FOR DEROGATION EFFECTS ON THE LOCALIZER PORTION OF THE INSTRUMENT LANDING SYSTEM G. Chin, L. Jordan, D. Kahn, S. Morin, D. Newsom, and A Watson Aug 1973 91 p

(AD-768049; DOT-TSC-FAA-73-13; FAA-RD-73-76) Avail: NTIS CSCL 17/7

The manual presents the complete ILSLOC computer program package. In addition to including a thorough description of the program itself and a commented listing, the manual contains a brief description of the ILS system and antenna patterns. To illustrate the program a test case was created and the figures of the case are incorporated in the report. Program DYNM and program ILSPLT are included as Appendices. The ILSPLT, complete with sample graphs, is a plotting routine for ILSLOC. For a technical mathematical analysis of the system, the FAA report Instrument Landing System Scattering No. FAA-RD-72-137 Author (GRA) should be consulted.

N74-14362# Tactical Air Warfare Center, Eglin AFB, Fla. SIMPLIFIED VISUAL APPROACH SLOPE INDICATOR (VASI) Final Report, 16 Apr. - 31 Jul. 1973 James F. Yealy Sep. 1973 28 p (AD-767901) Avail: NTIS CSCL 17/7

The purpose of this operational test and evaluation was to determine the value of a simplified visual approach slope indicator (VASI) system to the USAF Special Operations Force by accomplishing three test objectives; formulate and document construction criteria, establish user acceptance/rejection, and incorporate an air-transportable capability. Two types of systems were designed and constructed for user evaluation. Both were identical except for the support arrangement. One system was embedded in the ground, and the other was anchored to the ground by using sandbags. Both systems could be transported by air. Two hundred and eighty approaches were flown against the systems by 61 different pilots. The majority of pilots indicated that the systems were effective beginning at distances ranging from 1/2 to 1 mile and ending at 25- to 50-foot altitude (approximately 450 to 950 feet in front of the boards) during night or daytime operation. The best color combination was determined to be black stripe on white background. It was recommended that USAF Special Operations Force retain the two systems for potential future use during deployments to austere bases, temporary airfields, and landing zones not equipped with Author (GRA) standard VASI.

N74-14379 Connecticut Univ., Storrs.
THE SPECTRUM OF TURBOMACHINE ROTOR NOISE CAUSED BY INLET GUIDE VANE WAKES AND ATMO-SPHERIC TURBULENCE Ph.D Thesis

Donald Burnett Hanson 1973 142 p Avail: Univ. Microfilms Order No. 73-24404

A theoretical methodology is developed to calculate the partially coherent acoustic radiation of propellers, helicopter rotors. and axial flow fans due to inflow turbulence which is not plots of experimental data. The methodology is applied to two important cases: in the first case the rotor inflow contains non-homogeneous turbulence in the wakes of inlet guide vanes (IGV's) and in the second case it contains the turbulence ingested from the atmosphere which is highly anisotropic at low or zero Dissert. Abstr. forward flight speed.

N74-14383*# Scientific Translation Service, Santa Barbera. Calif.

REPRESENTATION OF HOT JET TURBULENCE BY MEANS OF ITS INFRARED EMISSION

J.-F. DeBelleval and M. Perulli Washington NASA Dec. 1973 24 p refs Transl. into ENGLISH from Office Natl. d'Etudes et de Rech. Aerospatiales (France), report tp-1277, 17-21 Sep. 1973 10 p

(Contract NASw-2483) (NASA-TT-F-15233: TP-1277) Avail: NTIS HC \$3.25 CSCL

20A The theoretical description of a jet acoustic radiation is characterized by turbulence data, defined at the scale of the total emissive volume. These data have average values in time, i.e. representing the whole spectrum. A representation of a hot jet turbulence by means of crossed spectral densities is presented. It is possible to define at any point of the source volume the characteristics turbulence data by frequency bands.

N74-14384*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SONIC INLET NOISE ATTENUATION AND PERFORMANCE WITH A J-85 TURBOJET ENGINE AS A NOISE SOURCE Harold W. Groth 1974 14 p refs Proposed for presentation at 12th Aerospace Sci. Meeting, Washington, D. C., 30 Jan. -1 Feb. 1974

(NASA-TM-X-71488; E-7823) Avail: NTIS HC \$3.00 CSCL 20A

A static test program was conducted to investigate aerodynamic and acoustic performance of a sonic inlet used as a noise suppressor. A translating centerbody type inlet with radial vanes was tested ahead of a J85-GE-13 turbojet engine. The inlet when fully choked, maintained high recovery with low distortions while dramatically reducing noise emanating from the compressor. Recoveries of 98.1% at simulated takeoff and 95% at approach were attained with associated sound attenuation of 40 db and 38 db respectively. Inlet lip shape was found to have significant effects on noise attenuation at these static conditions. Author

N74-14437 South Dakota State Univ., Brookings. THE UNSTEADY CIRCULATION DISTRIBUTION IN ROTORS AND ITS APPLICATION TO NOISE STUDIES Ph.D. Thesis Assem Fathy Aly Fathy 1973 103 p Avail: Univ. Microfilms Order No. 73-22970

A new method for the calculation of the unsteady circulation distribution in axial flow compressors was developed. The classical assumption of representing the rotor by a two dimensional infinite cascade was eliminated. Instead the more realistic case of a radial cascade with blades of finite length was studied. The value of the circulation calculated using the present analysis was used in the classical theory of compressor noise prediction to study the effects of the different compressor design parameters on the noise generated under different types of inlet disturbances. The results suggest that in reaching an optimum design based on minimum noise both steady and unsteady loading effects must be taken into consideration. Dissert. Abstr.

N74-14439# Cranfield Inst. of Technology (England). School of Mechanical Engineering.

ESTIMATION AND OPTIMIZATION OF THE FILM COOLING REQUIREMENTS IN A GAS TURBINE COMBUSTION CHAMBER

D. R. Ballal Oct. 1973 35 p refs (Cranfield-SME-5) Avail: NTIS HC \$3.75

The film cooling requirements of a gas turbine combustion chamber over a typical aircraft flight path were investigated. A computational procedure is used to estimate and optimize the coolant flow for a given value of the metal temperature along the whole length of the liner wall. Results are presented for a variety of mainstream and slot flow conditions. The effects of different film cooling geometries, mainstream turbulence, and hot gas acceleration were analyzed.

N74-14440# Cranfield Inst. of Technology (England) A PROPOSED METHOD FOR CALCULATING FILM-COOLED WALL TEMPERATURES IN GAS TURBINE COMBUSTION **CHAMBERS**

D. R. Ballal and A. H. Lefebvre, Jun. 1973, 20 p. refs. (Cranfield-SME-4) Avail: NTIS HC \$3.00

A method for calculating the film cooled wall temperatures in gas turbine combustion chambers was developed. Thermal paint tests were conducted at pressures up to 30 atmospheres to confirm the theoretical procedures. The data are applied to minimizing the amount of air used for film cooling of the jet engine combustion chambers as a method for reducing the amount of air pollutants generated by the engine.

N74-14444# Creare, Inc., Hanover, N.H. MODELING A HIGH PRESSURE RATIO CENTRIFUGAL COMPRESSOR USING A LOW SPEED OF SOUND GAS Final Report

James A. Block and Peter W. Runstadler, Jr. May 1973 245 p (Contract DAAJ02-70-C-0022; DA Proj. 1G1-62207-AA-71) (AD-767241; USAAMRDL-TR-73-18) Avail: NTIS CSCL 21/5

The results of a program are presented which demonstrate that low-speed-of-sound modeling is a practical tool for the research and development of high-pressure-ratio, high-speed centrifugal compressors. The compressor air performance and the details of its internal fluid dynamics were replicated at reduced rotational speed when a low-speed-of-sound gas was used. providing inlet Mach number, Reynolds number, and gas specific heat ratio were duplicated. Duplication of inlet specific heat ratio was essential to accurate modeling of the air-equivalent flow rate. Stage pressure ratio and stage efficiency were found to be less sensitive to the accurate replication of air-equivalent inlet specific heat ratio. (Modified author abstract)

N74-14445# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

RESEARCH ON NOISE GENERATED BY DUCTED AIR-FUEL COMBUSTION SYSTEMS Annual Report, 1 Mar. 1972 -28 Feb. 1973

Edelbert G. Plett, H. H. Chiu, and Martin Summerfield Mar. 1973 33 p refs

(Contract N00014-67-A-0151-0029; NR Proj. 094-366) (AD-767337: AR-2) Avail: NTIS CSCL 21/5

A two-pronged approach to the study of noise generation by combustion in a confined flow system, similar to a jet engine configuration, is described. One aspect deals with the mechanisms of noise generation by combustion; the other aspect deals with the effect of confinement on the noise generation and radiating properties of an unsteady solid-body-flow interaction. The mechanisms of noise generation by combustion are being studied analytically. It is noted that the steady flame structure determine the basic thermodynamic properties such as the sound speed and distribution of heat release, which affect amplification, dispersion and propagation of sound. The non-steady flame characteristics are responsible for noise generation; the turbulent scale, period and intensity affect the burning rate and heat release rate. The overall noise generation character is a superposition of the steady and non-steady acoustic characteristics. In studies with ducted and non-ducted sources, it is found that the interaction between the duct and the noise source can enhance the noise generation potential of the source region. The noise due to unsteady flow over small struts inside a duct is found to overwhelm the free jet noise up to speeds in excess of 1000 ft/sec.

N74-14447# Air Force Systems Command, Wright-Patterson AFB. Ohio. Foreign Technology Div.

LIFE OF FATIGUE CRACKS ON ROTOR BLADES OF TURBINES IN GAS TURBINE ENGINES

V. A. Pivovarov 21 Sep. 1973 14 p refs Transl, into ENGLISH from Vop. Dinam. i Prochnosti (USSR), no. 214, 1971 p 46-55

(AD-767947; FTD-HT-23-817-73) Avail: NTIS CSCL 21/5 The report presents experimental data derived from tests performed on gas turbine blades to ascertain the relationship between cracks and blade fatigue life. GRA

N74-14569 Lehigh Univ., Bethlehem, Pa. AN IMPROVED EXCEEDANCE THEORY FOR COMBINED RANDOM STRESSES WITH APPLICATION TO AIRCRAFT GUST RESPONSE Ph.D. Thesis

Harold C. Lester 1973 210 p Avail: Univ. Microfilms Order No. 73-23809

The general n-dimensional theory for calculating the average number of times per second that a random stress vector crosses an interaction boundary is developed. This represents an extension of Rice's classic solution for the exceedances of a constant level by a single random process to its counterpart for an n-dimensional random vector process. In the extension n jointly-stationary random processes forming the components of an n-dimensional stress vector are considered. A stress interaction boundary is assumed in the form of a closed surface imbedded in this n-dimensional stress space. The theory for the number of exceedances of an arbitrary stress interaction boundary is presented using a joint-statistical approach which fully accounts for all cross-correlation effects and leads to a closed-form expression for the exceedance density function.

N74-14594* National Aeronautics and Space Administration.
Langley Research Center, Langley Station, Va.
STRUCTURAL ANALYSIS OF LIGHT AIRCRAFT USING
NASTRAN

Michael T. Wilkinson (Louisiana Tech. Univ.) and Arthur C. Bruce (Louisiana Tech. Univ.) In its NASTRAN: Users' Experiences Sep. 1973 p 123-124 CSCL 20K

An application of NASTRAN to the structural analysis of light aircraft was conducted to determine the cost effectiveness. A model of the Baby Ace D model homebuilt aircraft was used. The NASTRAN model of the aircraft consists of 193 grid points connected by 352 structural members. All members are either rod or beam elements, including bending of unsymmetrical cross sections and torsion of noncircular cross sections. The aerodynamic loads applied to the aircraft were in accordance with FAA regulations governing the utility category aircraft.

N74-14599* Avco Lycoming Div., Stratford, Conn.

BLADE DYNAMICS ANALYSIS USING NASTRAN

Peter S. Kuo In NASA, Langley Res. Center NASTRAN:
Users' Experiences Sep. 1973 p 251-267 refs

CCCL 20K

The complexities of turbine engine blade vibration are compounded by blade geometry, temperature gradients, and rotational speeds. Experience indicates that dynamics analysis using the finite element approach provides an effective means for predicting vibration characteristics of compressor and turbine blades whose geometry may be irregular, have curved boundaries, and be subjected to high temperatures and speeds. The NASTRAN program was chosen to help analyze the dynamics of normal modes, rotational stiffening and thermal affects on the normal modes, and forced responses. The program has produced reasonable success. This paper presents the analytical procedures and the NASTRAN results, in comparison with a conventional beam element program and laboratory data.

N74-14816* Bell Helicopter Co., Fort Worth, Tex.
STATIC AND DYNAMIC HELICOPTER AIRFRAME ANALYSIS WITH NASTRAN

H. E. Wilson and J. D. Cronkhite In NASA. Langley Res. Center NASTRAN: Users' Experiences Sep. 1973 p 611-619 refs

CSCL 20K

The use of NASTRAN at Bell Helicopter Company for structural static and dynamic analysis of a helicopter airframe is described. Analysis of airframe internal loads, main rotor isolation systems, and airframe vibration is discussed. The use of each rigid format for these types of analysis is summarized. Suggested improvements to NASTRAN to increase its effectiveness in performing helicopter airframe analysis are given.

N74-14821* United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft.

MASTRAN DATA GENERATION OF HELICOPTER FUSE-LAGES USING INTERACTIVE GRAPHICS

J. B. Sainsbury-Carter and John H. Conaway In NASA. Langley Res. Center NASTRAN: Users' Experiences Sep. 1973 p. 661-678 refs CSCL 09B

The development and implementation of a preprocessor system for the finite element analysis of helicopter fuselages is described. The system utilizes interactive graphics for the generation, display, and editing of NASTRAN data for fuselage

models. It is operated from an IBM 2250 cathode ray tube (CRT) console driven by an IBM 370/145 computer. Real time interaction plus automatic data generation reduces the nominal 6 to 10 week time for manual generation and checking of data to a few days. The interactive graphics system consists of a series of satellite programs operated from a central NASTRAN Systems Monitor. Fuselage structural models including the outer shell and internal structure may be rapidly generated. All numbering systems are automatically assigned. Hard copy plots of the model labeled with GRID or elements ID's are also available. General purpose programs for displaying and editing NASTRAN data are included in the system. Utilization of the NASTRAN interactive graphics system has made possible the multiple finite element analysis of complex helicopter fuselage structures within design schedules.

N74-14625*# Boeing Commercial Airplane Co., Seattle, Wash.
ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF
AIRCRAFT METAL STRUCTURES REINFORCED WITH
FILAMENTARY COMPOSITES. PHASE 3: MAJOR
COMPONENT DEVELOPMENT Final Report

L. L. Bryson and J. E. McCarty Washington NASA Nov. 1973 112 p refs

(Contract NAS1-8858)

(NASA-CR-2122; D6-60136-3) Avail: NTIS HC \$4.25 CSCL 20K

Analytical and experimental investigations, performed to establish the feasibility of reinforcing metal aircraft structures with advanced filamentary composites, are reported. Aluminumboron-epoxy and titanium-boron-epoxy were used in the design and manufacture of three major structural components. The components were representative of subsonic aircraft fuselage and window belt panels and supersonic aircraft compression panels. Both unidirectional and multidirectional reinforcement concepts were employed. Blade penetration, axial compression, and inplane shear tests were conducted. Composite reinforced structural components designed to realistic airframe structural criteria demonstrated the potential for significant weight savings while maintaining strength, stability, and damage containment properties of all metal components designed to meet the same criteria. Author

N74-14631*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.
TRANSONIC SINGLE-MODE FLUTTER AND BUFFET OF A
LOW ASPECT RATIO WING HAVING A SUBSONIC AIRFOIL
SHAPE

Larry L. Erickson Washington Jan. 1974 24 p refs (NASA-TN-D-7346; A-4966) Avail: NTIS HC \$2.75 CSCL 01A

Transonic flutter and buffet results obtained from wind-tunnel tests of a low aspect ratio semispan wing model are presented. The tests were conducted to investigate potential transonic aeroelastic problems of vehicles having subsonic airfoil sections. The model employed NACA OOXX-64 airfoil sections in the streamwise direction and had a 14 deg leading edge sweep angle. Aspect ratio, and average thickness were 4.0, 0.35, and 8 percent, respectively. The model was tested at Mach numbers from 0.6 to 0.95 at angles of attack from 0 deg to 15 deg. Two zero lift flutter conditions were found that involved essentially single normal mode vibrations. With boundary layer trips on the model, flutter occurred in a narrow Mach number range centered at about Mach 0.90. The frequency and motion of this flutter were like that of the first normal mode vibration. With the trips removed flutter occurred at a slightly high Mach number but in a mode strongly resembling that of the second normal mode.

Autho

N74-14650*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE EFFECT OF WATER INJECTION ON NITRIC OXIDE EMISSIONS OF A GAS TURBINE COMBUSTOR BURNING ASTM 16T. A FIJE!

ASTM JET-A FUEL Nicholas R. Marchionna, Larry A. Diehl, and Arthur M. Trout Washington Dec. 1973 24 p refs. (NASA-TM-X-2958: E-7531) Avail: NTIS HC \$2.75 CSCI

Tests were conducted to determine the effect of water injection on oxides of nitrogen (NOx) emissions of a full annular, ram induction gas turbine combustor burning ASTM Jet-A fuel. The combustor was operated at conditions simulating sea-level takeoff and cruise conditions. Water at ambient temperature was injected into the combustor primary zone at water-fuel ratios up to 2. At an inlet-air temperature of 589 K (600 F) water injection decreased the NOx emission index at a constant exponential rate: NOx = NOx (o) e to the -15 W/F power (where W/F is the water-fuel ratio and NOx(o) indicates the value with no injection). The effect of increasing combustor inlet-air temperature was to decrease the effect of the water injection. Other operating variables such as pressure and reference Mach number did not appear to significantly affect the percent reduction in NOx. Smoke emissions were found to decrease with increasing water injection

N74-14651*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.

EFFECT OF WATER INJECTION ON NITRIC OXIDE EMISSIONS OF A GAS TURBINE COMBUSTOR BURNING NATURAL GAS FUEL

Nicholas R. Marchionna, Larry A. Diehl, and Arthur M. Trout Washington Dec. 1973 26 p refs (NASA-TM-X-2959; E-7565) Avail: NTIS HC \$3.00 CSCL

20M

The effect of direct water injection on the exhaust gas emissions of a turbolet combustor burning natural gas fuel was investigated. The results are compared with the results from similar tests using ASTM Jet-A fuel. Increasing water injection decreased the emissions of oxides of nitrogen (NOX) and increased the emissions of carbon monoxide and unburned hydrocarbons. The greatest percentage decrease in NOX with increasing water injection was at the lowest inlet-air temperature tested. The effect of increasing inlet-air temperature was to decrease the effect of the water injection. The reduction in NOX due to water injection was almost identical to the results obtained with Jet-A fuel. However, the emission indices of unburned hydrocarbons, carbon monoxide, and percentage nitric oxide in NOX were not.

N74-14669 Deutsche Forschungs- und Versuchsanstalt füer Luft- und Raumfahrt, Porz (West Germany). SECTION 2: FLIGHT MECHANICS, FLIGHT CONTROL [FACHGEBIET 2: FLUGMECHANIK, FLUGFUEHRUNG]

In its DFVLR Annual Review, 1972 1972 p 95-149 refs in GERMAN; ENGLISH summary

Aviation oriented problems studied pertain to operational procedures to increase aircraft handling qualities and flight safety. Development of redundant control systems for satellite, missile, and aircraft guidance is discussed. Special flight systems consider rescue and recovery methods for military applications.

Transl, by G.G.

N74-14670 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany), SECTION 3: STABILITY, CONSTRUCTION MATERIALS, CONSTRUCTION METHODS [FACHGEBIET 3: FESTIG-KEIT, WERKSTOFFE, BAUWEISEN In its DFVLR Annual Review, 1972 1972 p 151-197 refs In GERMAN; ENGLISH summary

Research in relation to aerospace industrial application stresses problems of structure, materials, and design. Strength and stability of structures subjected to temperature and other stress fields are considered in the framework of aeroelastic and aeromechanical problems of aircraft and spacecraft. Weight optimal utilization of fiber reinforced composite meterials is emphasized. Transl. by G.G.

N74-14675 Deutsche Forschungs- und Versuchsanstalt füer Luft- und Raumfahrt, Porz (West Germany). AEROTECHNOLOGY IN AVIATION PROBLEMS ILUFT-FAHRTTECHNISCHER BEREICH In its DFVLR Annual Review, 1972 1972 p 383-401 refs In GERMAN: ENGLISH summary

Scientific-engineering coordination with Federal ministries and industries is provided in planning, accomplishing, and evaluating aviation problems of safety and traffic regulations. This includes supplying of pilots and aircraft for scientific tasks of research Transl by G.G.

N74-14682*# Techtran Corp., Glen Burnie Md. ECONOMICS OF AIR TRANSPORT

M. C. Alvarez Washington NASA Jan. 1974 20 p. Transl. into ENGLISH from Rev. Aeron. Astron. (Spain), no. 388, Mar. 1973 p 173-183

(Contract NASw-2485)

(NASA-TT-F-15249) Avail: NTIS HC \$3.00 CSCL 05C

The costs of air transportation are analyzed, giving attention to direct and indirect costs. Systems of cost analysis are considered together with the effect of individual parameters on the costs of operation. Attention is given to cruising speed, flight time, total operational time, aircraft design, and aircraft manufacture. A first estimation of operational costs has to take into account the weight of the aircraft, the weight of the fuel needed during the flight, the fuel reserve, and questions of the selection of one of three operational approaches in conducting the flight. Direct costs of the flight operation are discussed in detail together with expenses for maintenance, inspection, depreciation, and fuel costs. Indirect expenses include costs of administration, publicity, and airport charges. Author

N74-14701 Engineering Sciences Data Unit, London (Eng-

PROFILE DRAG AT THE DRAGE-RISE CONDITION OF AEROFOILS HAVING A SPECIFIED FORM OF UPPER-SURFACE PRESSURE DISTRIBUTION AT THIS CONDI-TION

Oct. 1973 5 p refs

(ESDU-67011) Copyright. Avail: Issuing Activity

The development of airfoils based on an inviscid flow theory incorporating a description of compressibility effects is discussed. An inversion of the method has led to the derivation of a new family of airfoils in which boundary layer displacement effects and the use of compressibility factors are significant. A method for obtaining the profile drag of the airfoils is reported. The drag coefficient increments for the redesigned airfoils are plotted in graph form. The drag coefficient increments for the upper surface, lower surface, and total, for fully attached flow are presented.

N74-14704 Ohio State Univ., Columbus. THE EFFECTS OF HYPERSONIC VISCOUS INTERACTION ON STATIC STABILITY OF SLENDER BODIES IN SIMU-LATED NON-EQUILIBRIUM FLOWS Ph.D. Thesis Robert William Betts 1973 103 p Avail: Univ. Microfilms Order No. 73-26772

One phase of a similitude study of slender bodies in low density nonequilibrium flow is reported. Force and moment coefficients were obtained for a 10 degree half-angle cone at hypersonic, low density conditions for which viscous interaction is important. Measurements were made over an angle of attack from 0 to 10 degrees. By the introduction of selected amounts of argon to air it was possible to simulate the range of specific heat ratio variation from 0 to 100 percent oxygen dissociation in air. Both Newtonian theory and a modified version of tanget

cone theory (MTC) were used to define the similitude parameters applicable to both free flight and wind tunnel data. Dissert. Abstr.

N74-14705 Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.

FORCE MEASUREMENTS ON CARET AND DELTA WINGS OVER THE INCIDENCE RANGE 27 DEG LESS THAN OR EQUAL TO ALPHA LESS THAN OR EQUAL TO 55 DEG AT M 12.2

C. J. Carr Oct. 1971 11 p refs

(IC-Aero-71-22)

A series of tests measuring and comparing the forces on a flat bottom delta wing and a caret wing performed at M 12.2 over the incidence range 27 deg to 55 deg. The wings were of identical planform and thickness. The caret wing exhibited higher values of normal force, lift, and drag coefficients than the flat delta for any given incidence within the range tested.

N74-14706 Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.

THE FLOW FIELD AND PRESSURE DISTRIBUTION OF AN ISOLATED ROAD WHEEL

J. E. Fackreil and J. K. Harvey 1972 11 p refs Sponsored partly by Sci. Res. Council and Dunlop Tyre Co. (IC-Aero-72-14)

The air flow around two wheel profiles typical of those used on racing cars was studied. The flow around a stationary wheel is compared with that around the same wheel when rotating in order to highlight the specific effects of rotation. Lift and drag are calculated from pressure distributions over the wheels. The distributions themselves reveal useful information on the flow field. Total head measurements of the flow around the wheel Author (ESRO) and some special features are discussed.

N74-14707*# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

FLUTTER COMPUTER PROGRAM AND LIFTING SURFACE THEORY WITH BOUNDARY LAYER] Semiannual Progress Report, 1 Apr. - 1 Oct. 1973

Earl H. Dowell and C. Samuel Ventres 1 Oct. 1973 7 p refs (Grant NGR-31-001-197)

(NASA-CR-136559) Avail: NTIS CSCL 01A

A flutter program has been developed for a rectangular, orthotropic panel on point supports of finite stiffness as well as edge, line supports of finite stiffness. To check the flutter program, per se, simple piston theory aerodynamics were used. Lifting surface theory with boundary layer was used to solve the incompressible, steady, two dimensional flow problem. Author

N74-14708# National Research Council of Canada, Ottawa (Ontario).

AN EXPERIMENTAL ANALYSIS AND BUFFET INVESTIGA-TION OF THE SHOCKLESS LIFTING AIRFOIL NO. 1

J. J. Kacprzynski Aug. 1973 52 p refs (NRC-13673; LR-569) Avail: NTIS HC \$4.75

Wind tunnel tests to determine the aerodynamic characteristics of a shockless lifting airfoil were conducted. The improvements to the wind tunnel which led to conducting the tests are described. The experiments were performed with 20.5 percent porosity of the top and bottom walls of the test section. The aerodynamic coefficients obtained from integration of the pressure distribution and from the balance and wake drag measurements are listed. Buffet characteristics were investigated at Mach numbers of 0.51, 0.621, 0.7, and 0.768. The buffet boundaries determined from oscillations of the normal force component correspond well with Author the pressure divergence observed.

N74-14709# Advisory Group for Aerospace Research and Development, Paris (France).

AERODYNAMIC DRAG

Oct. 1973 469 p refs Partly in ENGLISH and partly in FRENCH Proc. of the Fluid Dyn. Panel Specialists Meeting. izmir, Turkey, 10-13 Apr. 1973

(AGARD-CP-124) Avail: NTIS HC \$25.50

The proceedings of a conference on aerodynamic drag are presented. Current research and future prospects in the field of aerodynamic drag are considered. Main emphasis was placed on subjects of practical value to the aerospace industry in relation to the need for accurate prediction, measurement, and alleviation of drag. Some of the subjects considered are: (1) aircraft drag, (2) wing drag. (3) base drag and separation, (4) interaction effects, (5) hypersonic drag, and (6) testing techniques and correlation of flight test and wind tunnel test data.

N74-14710 Ministry of Defence, London (England). TECHNICAL EVALUATION REPORT

S. F. J. Butler In AGARD Aerodyn, Drag Oct. 1973 11 p

A primary objective of research on aerodynamic drag is the development and proving of prediction methods in a form suitable for direct use by aircraft development teams and by those who have to assess the relative merits of alternative designs. Aircraft drag estimation methods are needed at various levels of sophistication and reliability. Basic statistical analyses can form the basis of an acceptable forecasting procedure at the feasibility stage, although such an approach is essentially conservative and can lead to the perpetuation of low design standards, as well as being of little use when novel aircraft design concepts are under consideration. Of some significance is the ability to predict reliably the drag of a datum streamlined aircraft with fully-turbulent flow, against which achieved drag levels can be compared in a figure-of-merit approach. During the design development and refinement stage, the research aims include the achievement of drag design objectives and the limitation of drag growth. In this phase, drag predictions in practice must be prepared by a process of synthesis (rather than simple summation), within a format which can readily accommodate the changing sources of data.

N74-14711 Lockheed-Georgia Co., Marietta.
A SURVEY OF DRAG PREDICTION TECHNIQUES APPLI-CABLE TO SUBSONIC AND TRANSONIC AIRCRAFT DESIGN

J. H. Patterson, D. G. MacWilkinson, and W. T. Blackerby In AGABD Aerodyn, Drag Oct. 1973 38 p. refs

The following aspects of aircraft drag prediction in the subsonic to transonic range are discussed: (1) preliminary estimation procedures, (2) estimation using wind tunnel test data, and (3) wind tunnel data and flight test data correlation. Inaccuracies in the approach to the use of flat plate skin friction, with appropriate shape factors, to predict profile drag are identified. Attempts to use low Reynolds number wind tunnel drag levels to predict full scale drag are shown to be reasonably successful. The prediction of C-5A aircraft drag characteristics from wind tunnel tests is discussed.

N74-14713 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Aerodynamik.

ON SOME BASIC AND NEW ASPECTS ABOUT THE DRAG PROBLEM OF WINGS AND BODIES IN SUPERSONIC FLOWS

Arabindo Das In AGARD Aerodyn, Drag Oct. 1973 26 p

With the objective to determine optimum shapes of slender wings and bodies for minimum total drag in supersonic flows a comprehensive theoretical and experimental analysis of the problem has been carried out. The theoretical formulas for the various drag components which are necessary for a variational problem of drag minimization have been reviewed, summarized, partly modified or extended, and finally compared with experimental values. Based on the linearized mass flux concept already known in the literature a modified boundary condition leads to a certain improvement in the results of the linear theory. A simplified treatment of the modified linear theory is presented. A unified approach to the problem of minimization of wave drag due to volume and wave drag due to lift yields very simple analytical results. The optimum body shapes show a certain dependence on Mach number. For minimization of vortex drag the necessary wing twist yields a remarkable improvement, which could also be verified by experiment. While the known friction drag formulas from the literature have been checked with

experimental values, the problem of base drag of axial symmetrical bodies has not been completely solved as yet; theoretical work on this topic is being continued.

N74-14714 Royal Aircraft Establishment, Bedford (England). MEASUREMENTS OF THE DRAG OF SOME CHARACTERIS TIC AIRCRAFT EXCRESCENCES IMMERSED IN TUR-BULENT BOUNDARY LAYERS

L. Gaudet and K. G. Winter In AGARD Aerodyn, Drag Oct. 1973 12 p refs

Measurements are described of the drag of various forms of excrescence mounted on balances installed in the walls of the working section of the RAE 8ft x 8ft wind tunnel. The tests cover a range of Mach numbers between 0.2 and 2.8 (but not transonic) and a range of Reynolds number. The excrescences tested include two-dimensional steps and ridges, circular cylinders and wings mounted normal to the surface, and holes and fairings. It is shown, for excrescences which are of height small compared with the boundary-layer thickness, that the scale effects on drag are well correlated in terms of the wall variables of the turbulent boundary layer, but that there is a dependence of drag on Mach number. For steps and ridges the effect of chamfering or rounding the upper corners was found to be beneficial at subsonic speeds but far less so at supersonic speeds. For circular holes the drag depends strongly upon the depth to diameter ratio. The fairings tested were either half-bodies of revolution with pointed or rounded ends or of square or rectangular section with pointed ends. The effects of different amounts of immersion of the bodies into the boundary layer was found in some cases by testing geometrically similar bodies of different sizes. Author

N74-14715 Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany)

PROBLEMS OF ESTIMATING THE DRAG OF A HELICOP-

S. N. Wagner In AGARD Aerodyn, Drag Oct. 1973 12 p

The components which contribute to the drag of a helicopter are identified as: (1) the drag of the main and tail rotors, (2) fuselage drag, (3) pylon drag, (4) landing gear drag, (5) fairing drag, and (6) drag caused by interference between the helicopter components. The difficulties and advantages of methods for defining the drag of a helicopter are analyzed. Procedures for testing small scale models of helicopters are discussed. The correlation of model data with flight test data is examined.

Author

N74-14716 Royal Aircraft Establishment, Farnborough (Eng-

AIRCRAFT DRAG PREDICTION FOR PROJECT APPRAISAL AND PERFORMANCE ESTIMATION

S. F. J. Butler In AGARD Aerodyn. Drag Oct. 1973 50 p

The principal stages in aircraft feasibility study and design development are considered leading to the specification of desirable characteristics of aircraft drag prediction models. The contributions to drag modelling to be expected from research are reviewed, together with the impact of computerized design selection and mission analysis methods. An assessment of the relative importance of different components and sources of drag introduces surveys, which examine the present state of the art of prediction for specific classes of aircraft and for particular aspects of drag. The main problems involved in executing and analysing model and aircraft tests are also discussed in the drag context. The collection, analysis and dissemination of data suitable for direct use in practical design methods are discussed. Author

N74-14717 Engineering Sciences Data Unit, London (Eng-

APPENDIX: A DATA ITEM SERVICE FOR AIRCRAFT DRAG **ESTIMATION**

In AGARD Aerodyn, Drag Oct. 1973 9 p refs

Avail: NTIS

The terms of reference for an engineering unit concerned with determining aerodynamic drag are discussed. The functions of the organization are defined: (1) to collect and disseminate information on drag prediction for sweptwing aircraft, (2) to arrange for the correlation and analysis of relevant data, (3) to formulate a comprehensive framework for the analysis and synthesis of aircraft drag, and (4) to encourage the introduction and adoption of improved drag prediction methods. Author

N74-14718 Douglas Aircraft Co., Inc., Long Beach, Calif. REMARKS ON METHODS FOR PREDICTING VISCOUS DRAG

A. M. O. Smith and Tuncer Cebeci. In AGARD. Aerodyn. Drag. Oct. 1973 12 p refs

While predictions of low speed profile drag are accurate for monoelement airfoils at low angle of attack, the methods are not very accurate at higher angles of attack, or for multielement airfoils or for fatter bodies of revolution. Two courses that might lead to possible improvement in accuracy have been investigated. One was an attempt to perform direct shear and pressure stress calculations on an airfoil or body. The other was an attempt to improve the Squire-Young momentum defect method by actually solving the wake for a short distance. The first method was not successful but the second method shows promise. Hence, it is tentatively concluded that refinement of the momentum defect method is the most promising path towards improved accuracy Author

N74-14719 National Aeronautical Establishment, Ottawa (Ontario)

DRAG OF SUPERCRITICAL AIRFOILS IN TRANSONIC FLOW

J. J. Kacprzynski In AGARD Aerodyn, Drag Oct. 1973 20 p

Analytical methods of evaluation of drag coefficients of contemporary supercritical airfoils are discussed. Some results of experimental values of drag coefficient for supercritical airfoils are compared against results of theoretical evaluations. Some results of drag coefficients of conventional airfoils are included for comparison. Difficulties of accurate experimental recording of drag coefficients are indicated. Author

N74-14720 General Dynamics/Convair, San Diego, Calif. Aerospace Div.

TRANSONIC DRAG DUE TO LIFT OF PLANAR JET-FLAPPED **AIRFOILS**

H. Yoshihara, R. Magnus, and D. Zonars (AFFDL) In AGARD Aerodyn, Drag Oct. 1973 8 p refs

In contrast to the low speed case test results indicate that lift augmentation by the jet flap in the transonic regime is accompanied, not by a large thrust recovery, but by a significant increase in drag. However to achieve moderate to high lifts the use of jet flaps rather than incidence has led to a significant reduction in the drag due to lift. To calculate the transonic jet flap flow a modified Spence jet flap condition is postulated and incorporated into the (unsteady) finite difference procedure. An example is then calculated and compared with experimental results.

N74-14721 National Aerospace Lab., Amsterdam (Nether-

COMPARISON OF VARIOUS METHODS FOR CALCULAT-ING PROFILE DRAG FROM PRESSURE MEASUREMENTS IN THE NEAR WAKE AT SUBCRITICAL SPEEDS

J. Zwaaneveld In AGARD Aerodyn, Drag Oct. 1973 12 p.

Methods for calculating the profile drag from total and static pressure measurements in aircraft wake have been compared. An analytical model of a compressible two-dimensional wake is used to obtain numerical results. Both the oldest method of Betz and the widely used method of Jones allow the static pressure variation across the wake to be taken into account. These methods are therefore suitable to treat the flow in the very near wake. The third method developed by Squire and

Young is in principle only valid when the static pressure variation across the wake is negligible. To extend this method to the more general case, two modifications are considered, the first as proposed by Squire and Young, the second as presented by the author. The latter modification makes use of the momentum integral equation with modified parameters. The numerical results show this new approach to be in far better agreement with the method of Jones than the first mentioned modified version.

Author

N74-14722 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

DRAG AND SEPARATION

Maurice Sirieix In AGARD Aerodyn, Drag Oct. 1973 23 p. refs in FRENCH; ENGLISH summary

The unsteady character of some separated flows and their resulting effects are discussed. The different types of turbulent separated flows of a limited extent and quasi-steady character are defined. The expected effects of these separated flows on the aerodynamic drag were studied. Theoretical methods of prediction are explained. Examples in which separated flows appear are analyzed.

N74-14723 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). NEW INVESTIGATIONS FOR REDUCING THE BASE DRAG OF WINGS WITH A BLUNT TRAILING EDGE Mauri Tanner In AGARD Aerodyn, Drag Oct. 1973 9 p refs

Investigations were conducted to determine methods for reducing the base drag of wings with blunt trailing edges. Measurements were performed on a rectangular wing in a low speed wind tunnel. The wing was fitted with broken trailing edges, splitter plates, and splitter wedges. The tests showed that the base drag could be substantially reduced by fitting a splitter wedge on the trailing edge. For the most advantageous splitter wedge, the base drag was nearly zero. In this case the maximum lift to drag ratio for the wing with a blunt trailing edge was as great as that for the corresponding wing with a conventional sharp trailing edge. Author

N74-14726 Air Force Flight Dynamics Lab., Wright-Patterson AFB Ohio

ASSESSMENT OF THE INFLUENCE OF INLET AND AFTBODY/NOZZLE PERFORMANCE ON TOTAL AIRCRAFT

Philip P. Antonatos, Lewis E. Surber, James A. Laughrey, and Donald J. Stava In AGARD Aerodyn. Drag Oct. 1973 28 p

The influence of propulsion system installation on aircraft drag is discussed. Using information from several investigations, different aspects of airframe propulsion integration are explored. each of which affects the assessment of aircraft drag. A great deal of apparently conflicting data has been generated on airframe-propulsion integration simply because the investigators concerned with different aspects of a system development have not properly integrated their own efforts to assure that theoretical analysis methods are consistent with wind tunnel test methods, that the test models are consistent with each other, and that adequate corrections for the effect of model mounting systems can be made. Even rather small inconsistencies in just a few of these considerations may result in errors of sufficient magnitude to affect aircraft design decisions adversely. A major part of the difficulty of making an accurate assessment of inlet/aftbody nozzle effect on aircraft drag is the prediction of flight performance from wind tunnel test data. Early system development should be studied carefully to assure that the program of airframepropulsion integration and the demands on propulsion related drag assessment are consistent with drag estimate accuracy for Author the airframe.

N74-14727 Boeing Commercial Airplane Co., Renton, Wash.
THE PROBLEM OF INSTALLING A MODERN HIGH BYPASS ENGINE ON A TWIN JET TRANSPORT AIRCRAFT Walter C. Swan and Armand Sigalla In AGARD Aerodyn. Drag Oct. 1973 12 p

An examination of the engine placement on a modern jet transport presents new drag and stability problems. Large high bypass ratio engines create large annular and wetted area drag and blockage surfaces which can cause difficult configuration problems as well as large interference drag and stability effects. The option is open to conventional underwing and aftbody mounted installations as well as renewed opportunity for over-the-wing installations. In this paper the drag and stability consequences for each class of configuration is examined for a typical intermediate range transport. The results are equally valid for short haul and certain STOL missions. In some instances, it is shown, proper pod shape and positioning may result in favorable drag increments, especially on modern swept wings with supercritical airfoil sections. Side effects such as pod influences on wing flutter, deep stall, and general sizing of the empennage are discussed.

N74-14729 Royal Aircraft Establishment, Bedford (England). THE DRAG OF EXTERNALLY CARRIED STORES: ITS PREDICTION AND ALLEVIATION

P. G. Pugh and P. G. Hutton In AGARD Aerodyn Drag Oct. 1973 11 p refs

The installed drag of stores makes a major contribution to the total drag of combat aircraft. It can be several times the sum of the free-air drags of the individual stores and its prediction and reduction are essential to the design of high-performance aircraft. Interference effects involved range from simple buoyancy to complex interactions involving viscous and wave drag phenomena. For the simpler cases there are good prospects that the installed drag can be accurately predicted either by current methods or by relatively straightforward extensions of these. However, empirical methods will continue to be needed for the prediction of the drag of complicated cases eg. multiple store arrays at transonic speeds. Some examples are given to

N74-14730 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). DRAG IN HYPERSONIC RAREFIED FLOW
Walter Wuest In AGARD Aerodyn. Drag Oct. 1973 12 p

show the opportunities for reducing the installed drag either by

redesigns to take advantage of improved mechanical systems or

through the development of radically new installations.

The drag force in hypersonic flow may be divided into cold pressure drag (incident molecules), temperature depending pressure drag (diffusively reflected molecules) and friction drag. The pressure drag dominates on blunt bodies which show a slighter drag variation with rarefaction whereas on slender bodies friction drag dominates and the total drag is strongly influenced by rarefaction. Relaxation and radiation do not appreciably alter the pressure drag but influence the flow field, stand-off distance Author of shock wave, and heat transfer.

N74-14731 Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique. DRAG OF LIFTING BODIES FOR PILOTS AT HIGH

ALTITUDE TRAINEE DE CORPS PORTANTS PILOTES A HAUTE ALTITUDE

J. Allegre, C. Matrand, and M. F. Scibilia In AGARD Aerodyn. Drag Oct. 1973 10 p refs in FRENCH; ENGLISH summary

Lifting bodies with 60 deg swept delta wings fitted out with control devices, located near the trailing edge of the wings are analyzed. The present experimental study of the aerodynamic behaviour of the wing is realized in a rarefied flow simulating a flight altitude of about 70 km. Experiments are performed in an open jet and continuously operating wind tunnel. The air flow is characterized by a Mach number of 8.1 and a free stream Reynolds number of 2200 per cm. Results show how much aerodynamic devices associated with the delta wing, like spoilers, remain

efficient and can be used in order to control the trajectory at high altitude. Drag coefficient data are given in the range of incidences between minus 20 deg and 20 deg. A comparison between efficiencies of trailing edge solid spoilers and trailing edge fluid spoilers allows to point out some advantages of the fluid spoilers. In particular, this jet control mechanism can create a sufficient side thrust without entailing a large increase of the

N74-14734 Naval Air Systems Command, Washington, D.C. DEVELOPMENT OF TECHNIQUES TO MEASURE IN-FLIGHT DRAG OF A US NAVY FIGHTER AIRPLANE AND CORRELA-TION OF FLIGHT MEASURED DRAG WITH WIND TUNNEL DATA

E. C. Rooney In AGARD Aerodyn, Drag Oct. 1973 18 p.

Wind tunnel and flight drag measurement techniques and correlation of wind tunnel and flight drag data for a U. S. Navy fighter airplane are discussed. Wind tunnel drag data were obtained with aerodynamic, induction system and powered nozzle/afterbody models. A common reference afterbody configuration between aerodynamic and propulsion models was utilized to assure compatibility of thrust and drag measurements. Flight drag data were obtained from steady-state, quasi steady-state and dynamic (wind-up/down turn) maneuvers utilizing sensitive three-axis accelerometers to determine excess thrust and the internal pressure method for measuring engine thrust. Compressor airflow, afterburner pressure drop and nozzle coefficients used for computing engine net thrust were obtained from isolated engine tests at simulated flight conditions throughout the flight envelope. Wind tunnel data were used to account for propulsion system drag caused by subcritical inlet spillage and nozzle interference drag. Author

N74-14735* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

REVIEW OF DRAG MEASUREMENTS FROM FLIGHT TESTS OF MANNED AIRCRAFT WITH COMPARISONS TO WIND-TUNNEL PREDICTIONS

Jon S. Pyle and Edwin J. Saltzman In AGARD Aerodyn. Drag Oct. 1973 12 p refs

In-flight studies of the overall and local components of drag of many types of aircraft were conducted. The primary goal of these studies was to evaluate wind-tunnel and semiempirical prediction methods. Some evaluations are presented in this paper which may be summarized by the following observations: Wind-tunnel predictions of overall vehicle drag can be accurately extrapolated to flight Reynolds numbers, provided that the base drag is removed and the boattail areas on the vehicle are small. The addition of ablated roughness to lifting body configurations causes larger losses in performance and stability than would be expected from the added friction drag due to the roughness. Successful measurements of skin friction have been made in flight to Mach numbers above 4. A reliable inflatable deceleration device was demonstrated in flight which effectively stabilizes and decelerates a lifting aircraft at supersonic speeds.

N74-14739*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. PLOTTING PROGRAM FOR AERODYNAMIC LIFTING SURFACE THEORY

Richard T. Medan and K. Susan Ray (Computer Sci. Corp., Mountain View, Calif.) Nov. 1973 31 p refs (NASA-TM-X-62321) Avail: NTIS HC \$3.75 CSCL 01A

A description of and users manual for a USA FORTRAN IV computer program which plots the planform and control points of a wing are presented. The program also plots some of the configuration data such as the aspect ratio. The planform data is stored on a disc file which is created by a geometry program. This program, the geometry program, and several other programs are used together in the analysis of lifting, thin wings in steady, subsonic flow according to a kernel function lifting surface theory.

N74-14740# Aeronautical Research Inst. of Sweden, Stock-

A QUICK LOOK AT THE STATE-OF-THE-ART IN FLIGHT TESTING OF CERTAIN AERODYNAMIC PARAMETERS RELATED TO WIND TUNNEL TESTING Final Report A. Bertelrud 1973 78 p refs (FFA-AU-966) Avail: NTIS HC \$6.00 CSCL 01A

Flight test techniques and the accuracy that can be obtained with the instrumentation and data reduction procedures are discussed. An analysis of the extent to which wind tunnel tests can reproduce the actual characteristics of real aircraft was conducted. The subjects considered are: (1) buffeting, (2) skin friction, and (3) maximum lift/stall characteristics. The types of instrumentation required to obtain data on various aerodynamic characteristics are reported. Author

N74-14741*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A STUDY OF THE NONLINEAR AERODYNAMICS OF BODIES IN NONPLANAR MOTION Ph.D. Thesis - Stanford

Lewis Barry Schiff Washington Jan. 1974 94 p refs (NASA-TR-R-421; A-5057) Avail: NTIS HC \$3.75 CSCL 01A

Concepts from the theory of functionals are used to develop nonlinear formulations of the aerodynamic force and moment systems acting on bodies in large-amplitude, arbitrary motions. The analysis, which proceeds formally once the functional dependence of the aerodynamic reactions upon the motion variables is established, ensures the inclusion, within the resulting formulation, of pertinent aerodynamic terms that normally are excluded in the classical treatment. Applied to the large-amplitude. slowly varying, nonplanar motion of a body, the formulation suggests that the aerodynamic moment can be compounded of the moments acting on the body in four basic motions: steady angle of attack, pitch oscillations, either roll or yaw oscillations, and coning motion. Coning, where the nose of the body describes a circle around the velocity vector, characterizes the nonplanar nature of the general motion.

N74-14744# National Aerospace Lab., Tokyo (Japan). MEASUREMENTS OF ROLLING MOMENTS ACTING ON THE STABILIZER OF T-TAILS OSCILLATING IN YAW Teruo Ichikawa, Koji Isogai, Yasukatsu Ando, and Hiroshi Ejiri 1973 10 p refs In JAPANESE; ENGLISH summary (NAL-TR-324) Avail: NTIS HC \$3.00

Low speed wind tunnel tests to determine aerodynamic rolling moments are discussed. Measurements were made of the forces acting on an isolated wing, with and without dihedral, at incidence and oscillating in yaw about the axis at the midchord point of the midspan. Tests were also conducted on the horizontal stabilizer of a T-tail configuration, with zero and finite angle of attack of the stabilizer, and oscillating in yaw about the axis through the fin midchord

N74-14745*# Calspan Corp., Buffalo, N.Y. ANALYSIS OF THE FLOW ABOUT DELTA WINGS WITH LEADING EDGE SEPARATION AT SUPERSONIC SPEEDS Joseph P. Nenni and Chee Tung [1973] 43 p refs (Contract NAS1-11577) (NASA-CR-132358) Avail: NTIS HC \$4.25 CSCL 01A

A research program was conducted to develop an improved theoretical flow model for the flow about sharp edge delta wings with leading-edge separation at supersonic speeds. The flow model incorporates a representation of the secondary separation region which occurs just inboard of the leading edge on such wings and is based on a slender-wing theory whereby the full three-dimensional problem is reduced to a quasi two-dimensional problem in the cross-flow plane. The secondary separation region was modeled by a surface distribution of singularities or a linearized type of cavity representation. The primary vortex and separation were modeled by a concentrated vortex and cut in the cross-flow potential which represents its feeding sheet. The cross-flow solutions for the cavity model were obtained, but these solutions have physical significance only in a very restricted range of angle

of attack. The reasons for the failure of the flow model are discussed. The analysis is presented so that other interested researchers may critically review the work.

N74-14746# Advanced Technology Labs., Inc., Westbury, N.Y. SIMILARITY PARAMETERS AND THEIR SENSITIVITY FOR TRANSONIC AIRFRAME EXHAUST NOZZLE INTERACTIONS Technical Report, 24 Jan. - 25 Sep. 1972
Gerald Roffle and Gabriel Miller Jan. 1973 75 p refs (Contract F33615-72-C-1362; AF Proj. 1476)
(AD-768988; ATL-TR-175; AFFDL-TR-73-9) Avail: NTIS CSCL 01/1

A qualitative description of the fluid mechanics of transonic airframe interaction with engine exhaust flows is formulated and used to derive the pertinent similarity parameters of the problem. The sensitivity of the flow field to these parameters is explored by computations and analysis of available data and leads to the conclusion that viscous parameters such as boundary layer momentum thickness, engine exit flow profiles and mass flux ratio have a pronounced effect on simulation capability. Based on the findings of the similarity and sensitivity studies, experiments are outlined for both continuous and blowdown facilities to investigate the role of viscous parameters more fully.

Author (GRA)

N74-14747# Boeing Aerospace Co., Seattle, Wash. Research and Engineering Div.

EXHAUST SYSTEM INTERACTION PROGRAM Final Technical Report

John E. Postlewaite and Victor Salemann Jun. 1973 178 p

(Contract F33615-70-C-1450; AF Proj. 3066) (AD-769086; D162-10467-13; AFAPL-TR-73-59) Avail: NTIS CSCL 01/3

The program consisted of two phases. The purpose of Phase 1 was to define what needs to be known, and when, and with what accuracy to define the engine cycle and thrust required by a proposed airplane, and to develop methods to obtain the required information -- particularly in the engine-exhaust system area. The second phase simulated the preliminary design and engine airframe matching portions of an airplane system development, stressing the evaluation of exhaust system installation losses at several levels of validity. This final report presents a summary of the work. The individual tasks are documented in seven volumes from Phase 1 (Vols. 1 - 7), ten volumes from Phase 1 (Vols. 8 - 17) of Ancilliary Reports (including D162-10467-12).

N74-14748# National Aeronautical Lab., Bangalore (India).
AERODYNAMIC ASPECTS OF THE PROBLEMS OF
AIR-INTAKES AND EXHAUST FOR A SUPERSONIC
TRANSPORT AIRCRAFT

J. Leynaert Nov. 1973 21 p refs Transl. into ENGLISH of "Aspects Aerodynamiques des Problemes de Prises d'Air et de Sorties de Reacteurs pour un Avion de Transport Supersoniques", French report ONERA-TP-124 Presented at Assoc. for Maritime and Aeronaut. Tech., Paris. 11-15 May 1964 (NAL-TR-194; NEAR-TP-124) Avail: NTIS HC \$3.25

An overall view of the aerodynamic problem of air intakes and exhaust for a supersonic transport aircraft flying at 2.2. Mach no. is given from the point of view of the design of the air-intake and the after body of the jet engine for supersonic cruise speeds with adaptation to intermediate flight speeds. Particular attention is given to the principle of boundary layer bleed at air-intake.

N74-14749# Institute of Transport Aviation, Paris (France): AVIATION NEEDS AND PUBLIC CONCERNS Emile VanLenner 29 Oct. 1973 22 p Presented at 7th Dr. Albert Plesman Mem. Lecture, Delft. Netherlands, 29 Oct. 1973 Avail: NTIS HC \$3.25

Economic profits in the continuous growth of civil aviation are weighed against the social impact on human life in the building of Europe's transportation network. Problems of aircraft noise, demands on energy resources, airport congestion, and consequently of environmental control are considered. G.G.

N74-14750# Edizioni Museo Aeronautico Caproni di Taliedo, Rome (Italy).

FORTY YEARS OF CIVIL AVIATION, 1931 - 1971 [QUARAN-TANNI DI AVIAZIONE CIVILE, 1931 - 1971]

Maria Quilici 1973 77 p refs In ITALIAN

Avail: NTIS HC \$6.00

A brief history of Italian civil aviation is presented. Articles published during this period are included. Transl. by F.O.S.

N74-14751*# Techtran Corp., Silver Spring, Md. CALCULATION AND ANALYSIS OF AIRCRAFT MOTION S. A. Gorbatenko, E. M. Makashov, Yu. F. Polushkin, and L. V. Sheftel Washington NASA Dec. 1973 379 p refs Transl. into ENGLISH of the book "Raschet i Analiz Dvizheniya Letatelnykh Apparatov" Moscow, Mashinostr., 1971 p 1-351 (Contract NASw-2485)

(NASA-TT-F-757) Avail: NTIS HC \$8.00 CSCL 018

Methods of calculating and analyzing motion, trajectories, transient processes, control and stability of aircraft are described. Calculation and properties of various guidance methods are discussed. Control based on linear automatic control theory, nonlinear mechanics and theory of stability of nonlinear systems are described. Problems of optimal control theory and methods of solution are explained. Numerical methods of calculating trajectories, transient processes, steady state flight and control optimization problems are presented.

N74-14752*# Kansas Univ. Center for Research, Inc., Lawrence

FLIGHT TEST DATA FOR A CESSNA CARDINAL

David L. Kohlman Washington NASA Jan. 1974 35 p refs (Grant NGR-17-002-072)

(NASA-CR-2337; FRL-72-001) Avail: NTIS HC \$3.00 CSCL 01C

The results of a flight test analysis of the performance of a standard Cessna 177B Cardinal airplane are presented. The airplane was fully instrumented to obtain steady state performance, stick-fixed dynamic stability characteristics, and roll response data. Results obtained include graphs of C sub L versus alpha. C sub D versus C sub L, and speed-power relationships. Dynamic data include Phugoid and Dutch characteristics, and roll response characteristics.

N74-14753*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif. HFL-10 LIFTING BODY FLIGHT CONTROL SYSTEM CHARACTERISTICS AND OPERATIONAL EXPERIENCE Weneth D. Painter and George J. Sitterle Washington Jan. 1974 35 p refs (NASA-TM-X-2956: H-704) Avail: NTIS HC \$3.00 CSCL 01C

A flight evaluation was made of the mechanical hydraulic flight control system and the electrohydraulic stability augmentation system installed in the HL-10 lifting body research vehicle. Flight tests performed in the speed range from landing to a Mach number of 1.86 and the altitude range from 697 meters (2300 feet) to 27,550 meters (90,300 feet) were supplemented by ground tests to identify and correct structural resonance and limit-cycle problems. Severe limit-cycle and control sensitivity problems were encountered during the first flight. Stability augmentation system structural resonance electronic filters were modified to correct the limit-cycle problem. Several changes were made to control stick gearing to solve the control sensitivity problem. Satisfactory controllability was achieved by using a nonlinear system. A limit-cycle problem due to hydraulic fluid contamination was encountered during the first powered flight. but the problem did not recur after preflight operations were improved Author N74-14754° # General Electric Co., Pittsfield, Mass.
ANALYSIS AND CALCULATION OF LIGHTNING-INDUCED
VOLTAGES IN AIRCRAFT ELECTRICAL CIRCUITS Final
Report

J. A. Plumer Washington NASA Jan. 1974 65 p refs. (Contract NAS3-14836)

(NASA-CR-2349; SRD-72-066) Avail: NTIS HC \$3.50 CSCL

Techniques to calculate the transfer functions relating lightning-induced voltages in aircraft electrical circuits to aircraft physical characteristics and lightning current parameters are discussed. The analytical work was carried out concurrently with an experimental program of measurements of lightning-induced voltages in the electrical circuits of an F89-J aircraft. A computer program. ETCAL, developed earlier to calculate resistive and inductive transfer functions is refined to account for skin effect. providing results more valid over a wider range of lightning waveshapes than formerly possible. A computer program, WING. is derived to calculate the resistive and inductive transfer functions between a basic aircraft wing and a circuit conductor inside it. Good agreement is obtained between transfer inductances calculated by WING and those reduced from measured data by ETCAL. This computer program shows promise of expansion to permit eventual calculation of potential lightning-induced voltages in electrical circuits of complete aircraft in the design stage.

N74-14755*# Washington Univ., St. Louis, Mo. School of

Author

Engineering and Applied Science.

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS. PHASE 1

Kurt H. Hohenemser and Gopal H. Gaonkar Sep. 1967 74 p. refs

(Contract NAS2-4151)

(NASA-CR-114707) Avail: NTIS HC \$5.75 CSCL 01C

A number of lifting rotor conditions with random inputs are discussed. The present state of random process theory, applicable to lifting rotor problems is sketched. Possible theories of random blade flapping and random blade flap-bending are outlined and their limitations discussed. A plan for preliminary experiments to study random flapping motions of a see-saw rotor is developed.

N74-14756*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS, PHASE 2

Kurt H. Hohenemser and Gopal H. Geonker Aug. 1968 56 p. refs.

(Contract NA\$2-4151)

(NASA-CR-114708) Avail: NTIS HC \$5.00 CSCL 01C

A comparison with NASA conducted simulator studies has shown that the approximate digital method for computing rotor blade flapping responses to random inputs, tentatively suggested in Phase I Report, gives with increasing rotor advance ratio the wrong trend. Consequently, three alternative methods of solution have been considered and are described: (1) an approximate method based on the functional relation between input and output double frequency spectra, (2) a numerical method based on the system responses to deterministic inputs and (3) a perturbation approach. Among these the perturbation method requires the least amount of computation and has been developed in two forms - the first form to obtain the response correlation function and the second for the time averaged spectra of flapping oscillations.

N74-14757*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS (THE EFFECTS OF SOME ROTOR FEEDBACK SYSTEMS ON ROTOR-BODY DYNAMICS), PHASE 7-A

Kurt H. Hohenemser and S. K. Yin Jun. 1973 92 p refs (Contract NAS2-4151)

(NASA-CR-114709) Avail: NTIS HC \$6.75 CSCL 01C

The effects of three gyroless rotor feedback systems: (1) coning feedback, (2) proportional tilting feedback, and (3) a combination of these on the rotor-body dynamics of hingeless rotorcraft are studied with a simplified analytical model in the advance ratio range from 0 to 8. Combinations of feedback phase angles and control phase angles are selected to minimize control cross coupling and control sensitivity changes between low and high speed flight. For the feedback systems thus selected the effects of feedback gain and control actuator time lag on the stability both with fixed hub and in free flight is studied, whereby the rotorcraft is free in pitch, roll and vertical motion but otherwise restrained. For the free flight is studied, whereby the rotorcraft is free in pitch, roll and vertical motion but otherwise restrained. For the free flight conditions the effects of a horizontal tail are also determined in itself and in combination with the rotor feedback systems. Author

N74-14758*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS (IDENTIFICATION OF LIFTING ROTOR SYSTEM PARAMETERS FROM TRANSIENT RESPONSE DATA). PHASE 7-R

Kurt H. Hohenemser and D. A. Prelewicz Jun. 1973 39 p. refs

(Contract NAS2-4151)

(NASA-CR-114710) Avail: NTIS HC \$4.00 CSCL 01C

System identification methods have been applied to rotorcraft to estimate stability derivatives from transient flight control response data. While these applications assumed a linear constant coefficient representation of the rotorcraft, the computer experiments used transient responses in flap-bending and torsion of a rotor blade at high advance ratio which is a rapidly time varying periodic system. It was found that a simple system identification method applying a linear sequential estimator also called least square estimator or equation of motion estimator, is suitable for this periodic system and can be used directly if only the acceleration data are noise polluted. In the case of noise being present also in the state variable data the direct application of the estimator gave poor results.

N74-14759*# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS (FURTHER EXPERIMENTS WITH PROGRESSING / REGRESSING ROTOR FLAPPING MODES), PHASE 7-C.

Kurt H. Hohenemser and S. T. Crews Jun. 1973 76 p refs (Contract NAS2-4151)

(NASA-CR-114711) Avail: NTIS HC \$6.00 CSCL 01C

The experiments with progressing/regressing forced rotor flapping modes have been extended in several directions and the data processing method has been considerably refined. The 16 inch hingeless 2-bladed rotor model was equipped with a new set of high precision blades which removed previously encountered tracking difficulties at high advance ratio, so that tests up to .8 rotor advance ratio could be conducted. In addition to data with 1.20 blade natural flapping frequency data at 1.10 flapping frequency were obtained. Outside the wind tunnel, tests with a ground plate located at different distances below the rotor were conducted while recording the dynamic downflow at a station .2R below the rotor plane with a hot wire anemometer.

N74-14760*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

PERFORMANCE OF A BALLUTE DECELERATOR TOWED BEHIND A JET AIRPLANE

Jon S. Pyle, James R. Phelps, and Robert S. Baron Dec. 1973 26 p. refs

(NASA-TM-X-56019; H-815) Avail: NTIS HC \$3.50 CSCL O1C

An F-104B airplane was modified to investigate the drag and stability characteristics of a ballute decelerator in the wake of an asymmetrical airplane. Decelerator deployments were initiated at a Mach number of 1.3 and an altitude of 15.240 meters (50,000 feet) and terminated when the airplane had decelerated to a Mach number of 0.5. The flight tests indicated that the decelerator had a short inflation time with relatively small opening forces. The drag levels attained with the subject decelerators behind a symmetrical tow vehicle. The ballute demonstrated good stability characteristics behind the testbed airplane.

N74-14762*# General Dynamics/Convair, San Diego, Calif. Convair Aerospace Div.

COMPUTER PROGRAM TO PERFORM COST AND WEIGHT ANALYSIS OF TRANSPORT AIRCRAFT. VOLUME 1: SUMMARY Final Report

Nov. 1973 92 p refs (Contract NAS1-11343)

(NASA-CR-132361) Avail: NTIS HC \$6.75 CSCL 01C

A digital computer program for evaluating the weight and costs of advanced transport designs was developed. The resultant program, intended for use at the preliminary design level. incorporates both batch mode and interactive graphics run capability. The basis of the weight and cost estimation method developed is a unique way of predicting the physical design of each detail part of a vehicle structure at a time when only configuration concept drawings are available. In addition, the technique relies on methods to predict the precise manufacturing processes and the associated material required to produce each detail part. Weight data are generated in four areas of the program. Overall vehicle system weights are derived on a statistical basis as part of the vehicle sizing process. Theoretical weights, actual weights, and the weight of the raw material to be purchased are derived as part of the structural synthesis and part definition processes based on the computed part geometry. Author

N74-14763*# General Dynamics/Convair, San Diego, Calif. Convair Aerospace Div.

COMPUTER PROGRAM TO PERFORM COST AND WEIGHT ANALYSIS OF TRANSPORT AIRCRAFT. VOLUME 2: TECHNICAL VOLUME Final Report

Nov. 1973 185 p refs (Contract NAS1-11343)

(NASA-CR-132362) Avail: NTIS HC \$11.25 CSCL 01C

An improved method for estimating aircraft weight and cost using a unique and fundamental approach was developed. The results of this study were integrated into a comprehensive digital computer program, which is intended for use at the preliminary design stage of aircraft development. The program provides a means of computing absolute values for weight and cost, and enables the user to perform trade studies with a sensitivity to detail design and overall structural arrangement. Both batch and interactive graphics modes of program operation are available.

Author

N74-14764# National Aerospace Lab., Tokyo (Japan).
GROUND OPERATION TESTS OF FLYING TEST BED FOR
VTOL AIRCRAFT AT NATIONAL AEROSPACE LABORATORY

Naoto Takizawa, Yoshikazu Tanabe, Akiyoshi Shibuya, Toshio Ogawa, Hirotoshi Fujieda, Tadao Kai, Yoshito Miyamoto, Koichi Ono, and Tadao Torisaki 1973 57 p refs In JAPANESE; ENGLISH summary

(NAL-TR-319) Avail: NTIS HC \$5.00

The ground operation tests of a flying test bed designed to investigate problems of hovering, vertical takeoff, and landing of vertical takeoff aircraft are discussed. During the tests, the flying test bed was fixed on a force test stand at a height of about six feet and controlled remotely from a control room. Total engine running time was about five hours in forty four operations and approximately thirty items were measured in each operation by special wiring, telemetry, and other methods.

N74-14765*# Boeing Vertof Co., Philadelphia, Pa.
A STUDY OF THE EFFECT OF FLIGHT DENSITY AND BACKGROUND NOISE ON V/STOL ACCEPTABILITY, Final Report

Harry Sternfeld, Jr., Ernest G. Hinterkeuser, Roy B. Hackman, and Jerry Davis Washington NASA Jan. 1974 84 p refs (Contract NAS1-11607)

(NASA-CR-2197; D210-10662-2) Avail: NTIS HC\$3.75 CSCL 01C

A study was conducted in which test subjects evaluated the sounds of a helicopter, a turbofan STOL and a turbojet airplane while engaged in work and leisure activities. Exposure to a high repetitive density of the aircraft sounds did not make the individual sounds more annoying but did create an unacceptable environment. The application of a time duration term to db(A) resulted in a measure which compared favorably with EPNL as a predictor of annoyance. Temporal variations in background noise level had no significant effect on the rated annoyance.

Author

N74-14766# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

CALCULATION OF THE INDUCED VELOCITY FIELD ON AND OFF THE WING PLANE FOR A SWEPT WING WITH GIVEN LOAD DISTRIBUTION

C. C. L. Sells London Aeron, Res. Council 1973 41 p. refs Supersedes RAE-TR-69231: RAE-TR-70146: ARC-32144; ARC-32549

(ARC-R/M-3725; RAE-TR-69231; RAE-TR-70146; ARC-32144; ARC-32549) Avail: NTIS HC\$4.25; HMSO £ 1.55;

ARC-32144; ARC-32549) Avail: NTIS HC\$4.25; HMSO & 1.55 PHI \$6.25

Computer programs have been written to evaluate the integrals of lifting-surface theory for the velocity field of a thin wing with given load distribution. Different programs are used for the downwash at points on the wing and for any or all three velocity components off the wing. The heart of the programs is an analytic evaluation of the spanwise integral over a short line following the local sweep; by combining a number of such integrals, the complete integral over the wing is built up. Both programs were tested by comparison with other results. The downwash program cannot compute the downwash at the apex of a swept wing with rounded isobars, nor exactly at a wing tip.

N74-14767# Royal Aircraft Establishment, Farnborough (England). Structures Dept.

SIMILARITY REQUIREMENTS FOR AEROELASTIC MODELS OF HELICOPTER ROTORS

G. K. Hunt London Aeron. Res. Council 1973 35 p refs Supersedes RAE-TR-72005, ARC-33730

(ARC-CP-1245; RAE-TR-72005; ARC-33730) Avail: NTIS HC \$3.75; HMSO 55p; PHI \$2.35

The parameters determining the dynamic similarity of flexible lifting rotors, ignoring thermal effects, are identified. Their relative importance is discussed and practical design procedures are developed for aeroelastic helicopter rotor models. A model should satisfy six similarity requirements. The full-scale Mach number and Froude number cannot be represented at the same time, and the full-scale Reynolds number cannot be represented at all. Hence models will generally be designed to achieve either Mach number or Froude number similarity. The uses, limitations, and characteristics of each kind of model are examined, and the interpretation of measurements obtained from them is explained. Most models are likely to be structural replicas, and the problems of making such models are discussed. The quality of construction, necessary to ensure that the models yield reliable Author (ESRO) experimental data, is shown to be high.

N74-14768# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.

COMPARISON OF THE FLYING QUALITIES OF THE A-7D AIRCRAFT WITH THE REQUIREMENTS OF MIL-F-8785B ASG Technical Report, Mar. - Dec. 1972

Daryl J. Joseph Apr. 1973 232 p refs (AD-768390; ASD-TR-73-15) Avail: NTIS CSCL 01/3

The report compares the flying qualities of the A-7D light attack airplane with the major flying qualities items of the Military Specification MIL-F-8785B(ASG). The comparison is based primarily on theoretical data supplemented as required by flight test data. The theoretical data is obtained from the contractor's report number 2-53320/8R-8089, dated 15 January 1968. The A-7D is aerodynamically the same as the A-7A; therefore, the A-7D estimated flying qualities are based on data obtained from flight tests of the A-7A airplane and A-7A model tests in the contractor's wind tunnel Author (GRA)

N74-14769# Air Force Inst. of Tech., Wright-Patterson AFB. Ohio. School of Engineering.

APPLICATION OF THE AEROSPACE MULTIPROCESSOR TO THE A-7D FLIGHT CONTROL SYSTEM M.S. Thesis Robert Russell Summers Jun. 1973 103 p refs (AF Proj. 6090)

(AD-768382; GGC/EE/73-17) Avail: NTIS CSCL 01/4

The application of the Aerospace Multiprocessor as the flight control computer for a digital fly-by-wire control system for the A-7D aircraft is described. First a brief discussion of the evolution of flight control systems, ranging from mechanical to digital fly-by-wire, is presented. Next, the topic of digital computers for aircraft flight control is covered. First general computer characteristics are discussed. This is followed by an extensive discussion of Aerospace Multiprocessor characteristics and principles of operation. The present analog flight control system for the A-7D aircraft is described. Various methods of digitizing the A-7D flight control system are considered. The Tustin method of digitization is covered at length, and difference equation derivations are shown in detail. The flight control microprogram written for the Aerospace Multiprocessor is described at a flowchart level. A multiply subroutine, written during this study, is described in detail. Then a description is given of the laboratory tests that were made with the Aerospace Multiprocessor programmed for flight control. Test results are discussed. Finally, the Aerospace Multiprocessor is evaluated regarding its suitability for use in a flight control application.

N74-14770# Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass

LDF POWERED BALLOON PROGRAM Instrumentation Papers

Arthur O. Koran, Richard C. Leclaire, and Catherine B. Rice 18 Jul. 1973 48 p refs

(AD-768673; AFCRL-TR-73-0424; ACRL-IP-198) Avail: NTIS CSCL 01/3

The report describes POBAL, a test flight to demonstrate the feasibility of accomplishing station-keeping by powering a 711,000-cu. ft. free balloon against the wind in the minimum wind field near 60,000-ft altitude. The propulsion system, fabricated from off the shelf components, incorporated a 35-ft diameter helicopter rotor and an 8-hp electric motor powered by Ag-Zn batteries. Line of thrust was controlled by a 9-ft high rudder, steerable either by radio command or by autopilot. POBAL was flown from Holloman AFB, New Mexico in September System components, flight results, recommendations and feasibility studies for a long duration POBAL system are discussed. Author (GRA)

N74-14771# Army Missile Command, Redstone Arsenal, Ala. METHODS FOR REDUCING VIBRATIONS OF EQUIPMENT MOUNTED ON HELICOPTER EXTERNAL STORES STA-TIONS

James M. Oliver 6 Aug. 1973 59 p. refs (DA Proj. 1M2-62303-A-214)

(AD-768774; RL-TR-73-6) Avail: NTIS CSCL 19/7

Three designs for reducing the vertical oscillations induced in equipment mounted on the wings of AH-1G helicopters are submitted. A design for a variable stiffness spring to accommodate a change in the mass of the system to be isolated is presented. By use of an analog simulation of a dynamic absorber it is shown that a dynamic absorber is not satisfactory for small ratios of damper mass to system mass. An experimental program is formulated to determine the dynamic properties of a test fixture to be used in determining isolator effectiveness.

Author (GRA)

N74-14772# Army Cold Regions Research and Engineering Lab. Hanover N.H.

OPERATIONAL EVALUATION OF THE 5K-5 AIR CUSHION VEHICLE IN ALASKA

Ronald A. Liston Sep. 1973 44 p refs

(AD-768781; CRREL-TR-243) Avail: NTIS CSCL 01/3

The report discusses the evaluation of the SK-5 air cushion vehicle, during operations on terrain typical of central Alaska. The intent of the evaluation was to consider the SK-5 as representative of the state of the art rather than as a candidate for a specific military role in Alaska. The study included tests to: determine slope-climbing ability, measure skirt drag, identify maneuverability as a function of surface conditions; determine air flow characteristics through the gap between the skirt and ground; and to identify the change in cushion pressure as a function of obstacle geometry. The test procedures and results are discussed. Conclusions for each test are drawn as is an overall conclusion concerning the potential value of air cushion vehicles in helping to solve Alaskan transportation problems.

Author (GRA)

N74-14773# LTV Aerospace Corp., Dallas, Tex. Vought Systems Div

DEFINITION OF STUDY OBJECTIVES FOR INTEGRATED CREW MODULE DEVELOPMENT Final Report, 1 Jul. 1972 - 31 Aug. 1973

E. R. Atkins, J. C. Hodges, T. L. Harper, J. R. Hankine, and A. A. Hall Aug. 1973 264 p refs (Contract N00014-72-C-(.143, NR Proj. 213-106)

(AD-769065; Rept-2-57110/3R-3104; JANAIR-730705) Avail:

NTIS CSCL 01/2

A study was conducted to identify and qualify objectives in the development of the integrated crew module crew station. The study efforts encompassed the man factor in addressing crew performance and the machine factor through analysis of critical design factors such as: (1) anthropometry, (2) geometry, (3) controls and displays, (4) vision, and (5) arrangement. A baseline configuration was developed from the studies. A significant portion of the study was devoted to the supine position of the crew member for acceleration tolerance improvement.

Author

N74-14774# Northrop Corp., Hawthorne, Calif. Electronics

IN-FLIGHT STABILIZATION OF EXTERNALLY SLUNG HELICOPTER LOADS Final Report, 25 Jun. 1970 - 17 Jun. 1972

David T. Liu May 1973 237 p refs (Contract DAAJ02-70-C-0067; DA Proj. 1F1-62203-A-435) (AD-769063; NORT-72-39; USAAMRDL-TR-73-5) Avail: NTIS CSCL 01/3

The purpose of the study was to select the best technical approaches for stabilizing a wide spectrum of externally slung helicopter loads at forward speeds up to 150 knots equivalent air speed (KEAS). This effort was accomplished in a two-phase program. Phase I was designed to identify and characterize typical sling loads, to establish their aerodynamic and dynamic characteristics, to gain physical understanding of helicopter/sling-load coupling dynamics, and to develop design approaches for stabilizing devices together with criteria and methodology for cost-effectiveness analysis. Phase II was devoted to the performance of a trade-off study of load stabilization systems, the formulation of preliminary design concepts for the most effective load stabilization approaches, and an evaluation of candidate stabilization systems using a moving-base flight simulator. (Modified author abstract)

N74-14775# Mechanical Technology, Inc., Latham, N.Y.
RECOMMENDED DESIGN MODIFICATIONS TO THE CH-47 FORWARD ROTOR DRIVE GEARBOX

Robert H. Badgley Jun. 1973 89 p. refs (Contract DAAJ02-72-C-0040; DA Proj. 1G1-62207-AA-72) (AD-769062; MTI-73TR1; USAAMRDL-TR-73-33) Avail: NTIS CSCL 01/3

The report describes the results of a study of modifications to existing helicopter power-train hardware for the purpose of reducing acoustic frequency vibrations and noise. Mechanical vibration analysis methods were put to further tests by applying them to the redesign of CH-47C gearbox components. This program was undertaken carefully and methodically to avoid the excessive costs which often accompany hit-or-miss approaches to gearbox noise reduction. The results include vibration reduction predictions for a number of carefully documented designs. The key products in this overall effort are reduced bearing radial dynamic forces: thus, the results of this program are expected to have major impact upon bearing and gear lifetimes, in addition to the obvious benefits in the area of gearbox noise. (Modified author abstract)

N74-14777# Army Materiel Systems Analysis Agency, Aberdeen Proving Ground, Md.

SIMPLIFIED AIRCRAFT PERFORMANCE METHODS: POWER REQUIRED FOR SINGLE AND TANDEM ROTOR HELICOPTERS IN HOVER AND FORWARD FLIGHT

C. Raymond Dietz Aug. 1973 57 p refs (AD-768769; AMSAA-TR-78) Avail: NTIS CSCL 01/3

The report presents a combination graphic and computing method for quick determination of shaft horsepower required for helicopters in hover and forward flight. Sets of equations were developed for computing power required. These equations are based upon theory and test data and show good agreement with published power required data on many currently operating helicopters. The equations have also been programmed for digital computation thereby making possible detailed studies of helicopter performance and the effects of parametric variations.

Author (GRA)

N74-14778# Southwest Research Inst., San Antonio, Tex. ENGINEERING APPRAISAL OF SOUTHWEST RESEARCH INSTITUTE MAGNETIC CRACK DEFINER APPLIED TO CH47 ROTOR BLADES

J. Robert Birchak, Robert R. King, C. Gerald Gardner, and John R. Barton Oct. 1973 57 p refs

(Contract DAAJ01-73-C-0533) (AD-769068; SwRI-15-3653; USAAVSCCM-TR-73-20) Avail:

NTIS CSCL 14/2

The Magnetic Crack Definer (MCD), a nondestructive evaluation device recently developed at Southwest Research Institute, was evaluated to determine the applicability for detecting fatigue cracks in CH-47 helicopter rotor blade spars (AISI 4340) in the fully assembled blade. For test purposes, fatigue cracks were produced by cyclically stressing several sheet specimens cut from a spar from a scrap blade. Several different probe configurations and other system parameters of the MCD were investigated, and after optimizing overall design, cracks as small as 0.3-inch long by 0.025-inch deep were reliably detected under the major adverse conditions associated with the blade, namely: varying lift-off up to 0.10-inch; and different types of overlaying materials, including stainless steel, fiberglass, mastic and adhesive. Additional investigations are recommended to determine the capability for detecting fatigue cracks under the ferromagnetic steel doubler plates, and to determine possible sources of false alarms. Author (GRA)

N74-14779# Hercules, Inc., Magna, Utah. Bacchus Works. GRAPHITE COMPOSITE LANDING GEAR COMPONENTS - SIDE BRACE ASSEMBLY AND TORQUE LINK FOR A37-8 AIRCRAFT Final Report. 15 May 1971 - 15 May 1973 R. E. Randolph, J. Witzel, J. N. Burns, H. L. T. Pritt. and J. C. Samisis. 15 May 1973 150 p refs (Contract F33615-71-C-1508: AF Proj. 1369) (AD-769041: H400-12-1-17; FFDL-TR-73-6923) Avail: NTIS CSCL 01/3

The effort deals with the design, fabrication and testing of three separate components of the main landing gear for A378 aircraft. Specifically, the upperside brace, lower side brace, and torque arm are involved. Designs of point loaded graphite/epoxy composite landing gear components along with their fabrication, including the use of chopped graphite/epoxy curing molds, are presented. The program demonstrated that complex components can be fabricated using chopped and continuous graphite/epoxy to withstand the static and fatigue loads encountered by the production metal components in service. Component weight savings as great as 50 percent have been achieved. (Modified author abstract)

N74-14780# Army Aviation Systems Command, St. Louis, Mo. Systems Performance Assessment Div.

MAJOR ITEM SPECIAL STUDY (MISS), AH-1G DRIVESHAFT ASSEMBLY, MAIN TRANSMISSION TO ENGINE Interim Report, 1 Jan. 1964 - 30 Jun. 1972

Oct. 1973 23 p

(AD-768763: USAAVSCOM-TR-73-26) Avail: NTIS CSCL 01/3

An analysis of the failures occurring with the H-1 helicopter and AH-1G helicopter drive shafts was conducted. The effects of the failures on logistics, spare parts, aircraft maintenance, and helicopter availity are described. The quality control and cost effective aspects of continuing to use the drive shafts are analyzed.

P.N.F.

N74-14781# Radio Corp. of America, Burlington, Mass. Aerospace Systems Div.
HELICOPTER INSPECTION DESIGN REQUIREMENTS
Douglas O. Blake, Fred W. Hohn, and Frank E. Starses May 1973 215 p. refs

(Contract DAAJ02-72-C-0052; DA Proj. 1F1-62201-A-119) (AD-769061; USAAMRDL-TR-73-22) Avail: NTIS CSCL 01/3

Existing aircraft and presently used inspection techniques were analyzed to determine the impact of present design on the ease of inspection. Initial engineering analyses established failure modes and inspection techniques for helicopter components which contribute significantly to the inspection problem. Analysis results were supplemented by field interviews with inspectors experienced in inspection of six aircraft types (AH-1, UH-1, CH-47. CH-54, OH-58, and OH-6). The field survey helped definitize components in each aircraft which present inspection problems. Problem areas were then reviewed and classified into categories. These categories included candidates for component or installation redesign, and changes in inspection technique or interval. Engineering analyses then explored for worthwhile solutions. This report contains the resulting specific recommendations for design approaches which offer improvements in inspection efficiency in future designs and inspection aids which warrant consideration for application to present or future designs. The MAVIS (Model for Analysis of Vehicle Inspection Systems) computer model, described in USAAMRDL Technical Report 72-35, was used to assess quantitatively the improvements in inspection efficiency available through the adoption of the study's recommendations. The modeling indicated significant reduction in maintenance man-hour requirements and improvement in aircraft availability Author (GRA) and mission reliability.

N74-14782# Army Aviation Systems Command, St. Louis, Mo.

MAJOR ITEM SPECIAL STUDY (MISS), AH-1G MAST ASSEMBLY Interim Report, Jan. 1964 - Jun. 1972

Oct. 1973 32 p (AD-768764: USAAVSCOM-TR-73-25) Avail: NTIS CSCL 01/3

The report describes a failure analysis performed on a helicopter antenna mast assembly.

N74-14783# Douglas Aircraft Co., Inc., Long Beach, Calif. DEVELOPMENT OF A GRAPHITE HORIZONTAL STABILIZER Interim Technical Report, 1 Jan. - 30 Jun. 1973 George M. Lehman, D. M. Purdy, A. Cominski, C. G. Dietz, and R. Teodosiadis Jul. 1973 82 p. refs [Contract N00166-70-C-1321]

(AD-768869; MDC-J6080) Avail: NTIS CSCL 01/3 The results of analyses and development component tests of the redesigned graphite horizontal stabilizer are presented. The upper and lower skin panels were redesigned with bonded internal stepped-lap titanium doublers at the main pivot and actuator fitting interfaces. The minimum predicted margin-of-safety for the redesigned pivot joint structure is 29% at the first fastener outboard of the titanium doubler. Three development components were fabricated and tested to verify the static and fatigue load capacities of the pivot joint and the static load capacity of the actuator joint. The pivot joint development component attained a static ultimate load of 170% Design Limit Load (DLL) and a residual static ultimate load of 195% DLL after 12,000 hours of simulated fatigue spectrum loading. The actuator joint development component attained a static ultimate load of 195% DLL. The calculated weight of the graphite structure is 183 pounds, an increase of approximately six pounds for the structural redesign, and a reduction of 26% in comparison with the conventional metal structure. Fabrication techniques for the upper and lower skin panels are discussed. Engineering drawings,

N74-15115# Instrument Flight Center, Randolph AFB, Tex. EVALUATION OF THE MODIFIED BENDIX AAU 19A/A AIMS ALTIMETER Final Report

quality control test results, and the test plan for the second

Author (GRA)

Manuel H. Tapia Aug. 1973 26 p (IFC Proj. TE-73-4)

stabilizer unit are included in appendices

(AD-768722; IFC-TR-73-8) Avail: NTIS CSCL 01/4

The USAF Instrument Flight Center, Research and Development Division (IFC/RD), evaluated the modified Bendix AAU 19A/A AIMS altimeter from a pilot factors point of view. The emphasis was placed on hang and lope deficiencies noted during the original IFC evaluation of the Bendix AAU 19A/A altimeter (IFC TR-73-2). Three different types of aircraft were used for the evaluation — a T-38 was used to investigate high performance capabilities of the altimeter while another altimeter was installed in a T-39 and a third in a T-29 to evaluate the altimeters: performance in a slower airspeed regime. Experienced instructor pilots from IFC/RD and several Instrument Pilot Instructor School (IPIS) student pilots evaluated the altimeter during 45 missions totaling approximately 60 hours of flying time. (Modified author abstract)

N74-15349# Advisory Group for Aerospace Research and Development, Paris (France).

TECHNICAL EVALUATION REPORT ON AGARD TECHNICAL MEETING ON ATMOSPHERIC POLLUTION BY AIRCRAFT ENGINES

Paul A. Libby (Calif. Univ., La Jolla) Nov. 1973 6 p. Presented at the Proc. of the Propulsion and Energetics Panel 41st Meeting, Regent's Park, Engl., 9-13 Apr. 1973

(AGARD-AR-63; AGARD-CP-125) Avail: NTIS HC \$3.00

The environmental problems associated with aircraft operations are discussed. Emphasis is placed on the general problem of air pollution in the neighborhood of airports due to aircraft engine exhaust products. The anticipated benefits from basic combustion research for reducing the pollutants in aircraft engine exhaust are examined. The necessity to determine the amount of pollution caused by aircraft engines as compared with vehicular traffic and adverse meteorological conditions as a basis for cost affective propulsion system modifications is stressed.

N74-15367# Air Force Cambridge Research Labs., L. G. Hanscom Field. Mass

THERMAL AND CHEMICAL FOG DISSIPATION: RESULTS OF FIELD EXPERIMENTS AT VANDENBERG AFB, CALIFORNIA DURING JULY 1972 Environmental Research Papers

Bruce A. Kunkel, Bernard A. Silverman, and Alan I. Weinstein 8 Aug. 1973 51 p. refs (AF Proj. 7605)

(AD-768671; AFCRL-TR-73-0502; AFCRL-ERP-454) Avail. NTIS CSCL 04/2

Results of thermal and chemical fog dispersal tests, conducted by AFCRL during July 1972, are presented and discussed. Forty-three tests were conducted in fog, thirty-three of which were suitable for analysis. Ninety-six additional heat tests were conducted in clear air. Two wide-area urea seeding tests were also performed. An instrumented 200-ft tower, a lidar, and a ground network of visibility sensors and droplet sampler were used to monitor the effects of the tests on the foggy environment. The seeding tests were unsuccessful. Improper execution of the wide-area seeding pattern due to a lack of knowledge of the winds at the seeding location was responsible for the failure of the seeding tests. (Modified author abstract)

N74-15378*# Stanford Univ., Calif. Guidance and Control lab

MULTI-INPUT, MULTI-OUTPUT REGULATOR DESIGN FOR CONSTANT DISTURBANCES AND NON-ZERO SET POINTS WITH APPLICATION TO AUTOMATIC LANDING IN A CROSSWIND

William E. Holley and Arthur E. Bryson, Jr. Aug. 1973 61 p. refs

(Grant NGL-05-020-007)

(NASA-CR-136618; SUDAAR-465) Avail: NTIS HC\$5.25 C\$CL 09C

Undesirable steady offsets result when a stationary, linear regulator using state feedback is subjected to constant disturbances and/or non-zero setspoints. To eliminate these offsets, the disturbances and non-zero setpoints can be fed forward to the control. Only when the number of outputs is less than or equal to the number of control inputs can the outputs be maintained at arbitrary non-zero setpoints. The state and the disturbance may be estimated using a constant gain Kalman filter or by modeling the constant disturbances as exponentially correlated processes with long correlation times.

N74-15379# Lincoln Lab., Mass. Inst. of Tech., Lexington. EMPIRICAL ASSESSMENT OF ATCRBS Final Report A. G. Cameron and D. H. Pruslin 31 Oct. 1973 227 p refs (Contracts DOT-FA72WAI-242; F19628-73-C-0002) [ATC-16; FAA-RD-73-139] Avaii: NTIS HC \$13.50

The operational performance of the FAA ATCRBS system, as determined from data extracted from the ARTS I!! digital processing system is discussed. Quantitative performance data, as well as discussion of the problem area and possible techniques and procedures for its solution, are provided in the areas of weak/broken targets, synchronous garble, interference, erroneous decoding, improper defruiter operation, and insufficient angular resolution. A discussion of improvements that can alleviate some of the deficiences of today's secondary radar (ATCRBS) system is included.

N74-15380# Texas Instruments, Inc., Austin.
FAILURE MODES, EFFECTS AND CRITICALITY ANALYSIS
(FMECA) OF CATEGORY III INSTRUMENT LANDING
SYSTEM WITH TRAVELING: WAVE LOCALIZER ANTENNA
Final Report, Jan. - Oct. 1973

Cliff White Oct. 1973 207 p refs (Contract DOT-FA71WA-2635)

(U1-840912-100; FAA-RD-73-111) Avail: NTIS HC \$12.50

A Faiture Modes. Effects and Criticality Analysis (FMECA) is used to optimize system performance by identification of all potentially hazardous failure modes affecting either personal safety of operational mission success. This in-depth systematic approach of such an analysis provides quantitative assurance of the system's reliability and integrity. The previous FMECA performed on the FAA Mark III ILS is updated in this analysis to determine the impact on localizer and system reliability of the additional equipment required by the substitution of the traveling wave

antenna array for the wide aperature parabolic antenna. All relevant hidden equipment failure modes are identified within the analysis and based upon allowable probabilities of occurrence, their respective preventive maintenance frequencies are specified.

Author

N74-15381# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PRO-GRAM. VOLUME 1: EXECUTIVE SUMMARY

27 Sep. 1972 40 p ref (Contract DOT-FA72WA-2803)

(FAA-RD-73-150-1) Avail: NTIS HC \$4.00

The design, development, and operation of a microwave landing system are presented. The technical features of the system are described to show the: (1) method of time reference measurement, (2) the scanning beam antenna using electronicallyswitched feed elements, and (3) the course deviation function. A multipath control technique is described which provides low angle microwave vertical guidance at angles close to the terrain. Diagrams of typical installations of the system are provided.

Author

N74-15382# Raytheon Co., Wayland, Mass. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PRO-GRAM. VOLUME 3: 1.1.1 PERFORMANCE VALIDATION 27 Sep. 1972 379 p refs (Contract DOT-FA72WA-2803)

(FAA-RD-73-150-3) Avail: NTIS HC \$21.00

The multipath and propagation problems of a microwave landing system are discussed. The specific sources of multipath transmission are identified and their effects on the system are analyzed. The influences of refraction, polarization, and rain attenuation are investigated. Proposed solutions are made for: (1) obstacle multipath, (2) ground reflection, (3) blockage, and (4) diffraction.

N74-15383# Raytheon Co., Wayland, Mass. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNICAL ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PRO-GRAM, VOLUME 3A

27 Sep. 1972 363 p refs (Contract DOT-FA72WA-2803)

(FAA-RD-73-150-3A) Avail: NTIS HC \$20.25

The parameters and processing methods that are critical to designing a precision distance measuring equipment system for use with a microwave landing system are discussed. The overall system accuracy, search times, and performance under high density environments are analyzed. Emphasis is placed on: (1) results of system capacity and interference analysis, (2) multipath summary, (3) DME power requirements and low angle coverage, and (4) DME dynamic range.

N74-15384# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PRO-VOLUME 4: SYSTEM CONSIDERATIONS 1.1.2 THROUGH 1.1.5

27 Sep. 1972 161 p refs (Contract DOT-FA72WA-2803)

(FAA-RD-73-150-4) Avail: NTIS HC \$10.25

The studies and ahalyses to support the development of a microwave landing system are presented. The subjects considered are: (1) the economic model and life cycle costs, (2) time reference angular measurement against coding on the beam, (3) integrity

enchancement by dual angle mode encoding, (4) beam forming network, (5) electronic scan compared with mechanical scan, and (6) system configuration and deployment tradeoffs. The compatibility of the microwave system with airport installations and with aircraft types, missions, and aerodynamics is analyzed.

N74-15385# Raytheon Co., Wayland, Mass.
MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION PHASE OF THE NATIONAL MLS DEVELOPMENT PRO-GRAM, VOLUME 5: POST TA/CD PLANS, MANAGEMENT PERFORMANCE

27 Sep. 1972 310 p refs (Contract DOT-FA72WA-2803)

(FAA-RD-73-150-5) Avail: NTIS HC \$17.50

The proposed methods for conducting a feasibility demonstration, prototype development, and limited production of a microwave landing system are discussed. The plans consist of: (1) test and evaluation, (2) analytical verification, (3) hardware design and fabrication, (4) prototype hardware design and fabrication, and (5) reliability and maintainability.

N74-15386# Raytheon Co., Wayland, Mass. MICROWAVE LANDING SYSTEM (MLS) DEVELOPMENT PLAN AS PROPOSED BY RAYTHEON DURING THE TECHNIQUE ANALYSIS AND CONTRACT DEFINITION
PHASE OF THE NATIONAL MLS DEVELOPMENT PRO-GRAM. VOLUME 6: SUPPORTING STUDIES, APPENDICES D THROUGH N

27 Sep. 1972 591 p refs (Contract DOT-FA72WA-2803)

(FAA-RD-73-150-6-App-D-N) Avail: NTIS HC \$31.75

Various studies which were conducted during the planning and development of a microweve landing system are presented. The subjects considered include the following: (1) obstacle multipath effects, (2) rough ground effects, (3) refraction, (4) convex runways, and (5) aircraft blockage. A summary of computer simulation results is developed. Circuit development practices and diagrams of subsystem circuits are provided.

N74-15454 Wisconsin Univ., Madison.

THE DIVIDED COMBUSTION CHAMBER CONCEPT AND DESIGN FOR CONTROL OF SI ENGINE EXHAUST AIR POLLUTANT EMISSIONS Ph.D. Thesis

Ibrahim Ahmed El-Messiri 1973 308 p Avail: Univ. Microfilms Order No. 73-19298

The divided combustion chamber engine was designed specifically for control of SI engine air pollutant emissions through basic modification of the combustion process within the engine. The basis for reduction of pollutant emissions is division of the combustion space into two regions, a primary chamber and a secondary chamber. These two chambers communicate via an orifice. Just prior to ignition the primary chamber contains a homogeneous combutible fuel-air mixture while the secondary chamber contains only air. Following ignition, burned combustion gases expand immediately and with high velocity into the secondary chamber, where rapid mixing with the relatively cool secondary chamber air suppresses further formation of nitric oxide. At the same time, further oxidation of carbon monoxide and unburned hydrocarbons, issuing from the primary chamber, occurs. The engine is operated with an overall fuel-air ratio that is leaner than chemically correct, thus affording control of unburned hydrocarbon carbon monoxide emissions as well as nitric oxide. Dissert, Abstr.

N74-15465* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FLIGHT VELOCITY EFFECTS ON JET NOISE OF SEVERAL VARIATIONS OF A 48-TUBE SUPPRESSOR INSTALLED ON A PLUG NOZZLE

Richard R. Burley and Verlon L. Head. Washington. Feb. 1974 38 p refs

(NASA-TM-X-2919: F-7513) Avail: NTIS HC \$3.00 CSCL 21E

Because of the relatively high takeoff speeds of supersonic transport aircraft, it is important to know if the flight velocity affects the poise level of suppressor nozzles. To investigate this. a modified F-106B aircraft was used to conduct a series of flyover and static tests on a 48-tube suppressor installed on an uncooled plug nozzle. Comparison of flyover and static spectra indicated that flight velocity had little effect on the noise suppression of the 48-tube suppressor configuration. However, flight velocity adversely affected noise suppression of the 48-tube suppressor with an acoustic shroud and plug installed. Author

N74-15466*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FLIGHT VELOCITY EFFECTS ON JET NOISE OF SEVERAL VARIATIONS OF A TWELVE-CHUTE SUPPRESSOR INSTALLED ON A PLUG NOZZLE

Richard R. Burley and Albert L. Johns Washington Feb. 1974 38 p refs

(NASA-TM-X-2918: E-7449) Avail: NTIS HC \$3.00 CSCL 21F

Because of the relatively high takeoff speeds of supersonic transport aircraft, it is important to know whether the flight velocity effects the noise level of suppressor nozzles. To investigate this, a modified F-106B aircraft was used to conduct a series of flyover and static tests on a 12-chute suppressor installed on an uncooled plug nozzle. Comparison of flyover and static spectra indicated that flight velocity adversely affected noise suppressions of the 12-chute configurations.

N74-15467# Air Force Systems Command, Wright-Patterson AFB. Ohio. Foreign Technology Div.

THE TESTING OF JET ENGINES, CHAPTERS 5 AND 5

L. S. Skubschevskii 6 Sep. 1973 69 p refs Transl. into ENGLISH from the publ. "Ispytaniya Vozdushno- Keakt ivnukh Dvigatele" USSR, 1972 115 p (AF Proj. G101)

(AD-768492; FTD-MT-24-345-73) Avail: NTIS CSCL 21/5 The report describes the structural parts of jet engine test stands and explains the function of each part.

N74-15468# Phillips Petroleum Co., Bartlesville, Okla. Research and Development Dept.

REDUCTION OF POLLUTANTS FROM AIRCRAFT TURBINE BY FUEL SELECTION AND PREVAPORIZATION Final Report, 14 Sep. 1972 - 14 Jun. 1973 H. T. Quigg Oct. 1973 184 p refs

(Contract N00140-72-C-6969)

(AD-769099; Rept-6607-73) Avail: NTIS CSCL 21/5

An investigation was conducted, using the Phillips 2-Inch. combustor operating under conditions simulating those in modern aircraft turbine engines, to provide information on the effects of hydrocarbon type and fuel volatility on flame radiance and exhaust emissions. Fuels used in the investigation were a JP-5 for reference and ten pure hydrocarbons (normal, iso-, and cycloparaffins and aromatics) with various boiling points within each hydrocarbon type. Hydrogen content of the fuels ranged from 7.7 to 16.4 weight per cent. The effects of differences in physical properties of the fuels were minimized by prevaporization before introduction to the combustor and maximized by using pressure atomization for injection of fuel to the combustor. Inlet air humidity was included as an operating variable. Empirical equations, based on fuel and operating variables were developed for prediction of flame radiance, NO, NOx, CO, and smoke. (Modified author abstract)

N74-15612 British Aircraft Corp., Preston (England) Military Aircraft Div

OPTIMISATION OF AIRCRAFT STRUCTURES WITH MULTIPLE STIFFNESS REQUIREMENTS

I. C. Taig and R. I. Kerr. In AGARD. Second Symp. on Structural Optimization Nov. 1973 14 p refs

A general optimality theorem is presented for structures whose members have stiffnesses proportional to their masses and which are designed by generalized stiffness requirements. The theorem is used to derive an iterative procedure for optimum structure design. Modifications to the basic theorem enable practical constraints such as minimum material gauges and strength or stability requirements to be introduced. The method can be used where stiffness requirements are directly specified for given loading conditions or where vibration frequency or aeroelastic efficiency requirements are stipulated. A useful feature of the method. when used in conjunction with automated design procedures, is that the optimization can operate with real structure variables and constraints so that there is no subsequent design operation required to convert idealised structure dimensions to feasible detail sizes. Several examples are quoted to show that very favorable results and computing times are obtainable for demonstration problems. The ability to handle major structural optimization is also illustrated by applications to actual airframe structures. Author

N74-15614 Messerschmitt-Boelkow-Blohm G.m.b.H., Hamburg (West Germany). Stress Dept.

OPTIMIZATION AND DESIGN OF THE REAR FUSELAGE OF THE A 300 B AIRCRAFT STRUCTURE

D. Schulz In AGARD Second Symp. on Structural Optimization Nov. 1973 15 p refs

A method is described for the automatically controlled calculation of a skin/stringer structure. The method was programmed and applied for the first time for the development of the Airbus A 300 B. The method can be considered as a link in a process chain, the target of which is the overall development of aircraft structures. It starts with the calculation of statically indeterminate forces and ends up with the statical strength analysis. Input and output data for the calculations of statically indeterminate forces are used as input data for structure dimensioning or strength analysis program. The structure dimensioning program iterativly modifies the originally defined wall thicknesses so that the reserve factors required to prevent failure under tensile, compression and shear loads are reached or only slightly exceeded in all critical load cases. The originally defined structural concept (stringer and frame spacing as well as stringer shapes) is not changed in this case. Final dimensioning is influenced by manufacturing considerations. On completion of the dimensioning work the dimensions are laid down and the strength analysis is carried out in a single computer run. The flow of the program is demonstrated in the example of the Airbus A 300 B rear fuselage. Author

N74-15659*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF INCREASED FUEL TEMPERATURE ON EMIS-SIONS OF OXIDES OF NITROGEN FROM A GAS TURBINE COMBUSTOR BURNING ASTM JET-A FUEL

Nicholas R. Marchionna Washington Jan. 1974 18 p refs (NASA-TM-X-2931; E-7634) Avail: NTIS HC \$2.75 CSCL 20M

An annular gas turbine combustor was tested with heated ASTM Jet-A fuel to determine the effect of increased fuel temperature on the formation of oxides of nitrogen. Fuel temperature ranged from ambient to 700 K. The NOx emission index increased at a rate of 6 percent per 100 K increase in fuel temperature Author

N74-15666# Georgia Inst. of Tech., Atlanta. School of Aerospace

COMBUSTION GENERATED NOISE IN TURBOPRO-PULSION SYSTEMS Interim Technical Report

B. N. Shivashankara, J. C. Handley, and W. C. Strahle 24 Jul. 1973 97 p refs

(Grant AF-AFOSR-2365-72; AF Proj. 9711)

(AD-768615; AFOSR-73-1899TR) Avail: NTIS CSCL 21/2 Experiments on noise radiation by open turbulent premixed flames are described. Detailed directionality distributions, scaling

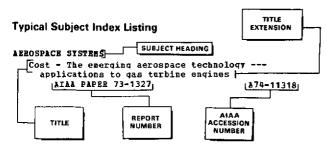
rules for acoustic power radiated, thermo-acoustic efficiency and spectral content are presented and discussed. Scaling rules for reacting volume are generated by a direct flame photography technique." These experiments are shown to be quite useful in decomposing combustion noise scaling laws. The acoustic power is shown to scale as U(2.7) D(2.8) SL(1.4) F(0.4), and combustion noise spectra peak in the 250-700 Hz range. The directionality is quite weak for noise from open turbulent flames. The experimental results are critically examined in the light of the theoretical predictions from Strahle's theory of combustion noise.

Author (GRA)

SUBJECT INDEX

AERONAUTICAL ENGINEERING / A Special Bibliography (Suppl. 43)

APRIL 1974



The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, a title extension is added, separated from the title by three hyphens. The NASA or AIAA accession number is included in each entry to assist the user in locating the abstract in the abstract section of this supplement. If applicable, a report number is also included as an aid in identifying the document.

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A	
A-7 ATRORAPT	
A modified design concept, utilizing deck a	otion
prediction, for the A-7E automatic carrie	r
landing system [AD-767691]	N74-13739
Comparison of the flying qualities of the A	-7D
aircraft with the requirements of MIL-Y-6	3785B ASG
[AD-768390]	N74-14768
Application of the aerospace multiprocessor A-7D flight control system developmen	it of
digital fly-by-wire system [AD-768382]	N74-14769
A-37 AIRCRAPT	
Graphite composite landing gear components	- side
brace assembly and torque link for A37 B	aircraft
[AD-769041]	N74-14779
A-300 AIRCRAFT A 300 B static and fatigue tests	
A 300 B Statte and latigue ceses	A74-16755
Optimization and design of the rear fuselag	e of
the 1 300 B aircraft structure	
	N74-15614
Ablation heat and mass transfer in hype	rsonic
flight	
2270	A74-17103
ACCELERATION STRESSES (PHYSIOLOGY)	_
Definition of study objectives for integrat	ted crew
module development [AD-769065]	N74-14773
ACOUSTIC ATTENUATION	M14 14172
Experimental study of the internal noise in	0
injector driven wind tunnels	
FONERA, TP NO. 1315]	A74-18288
Sonic inlet noise attenuation and performan	ice with
a J-85 turbojet engine as a noise source [AIAA PAPER 74-91]	174-1876B
ACOUSTIC MEASUREMENTS	274 10100
Recent developments in sonic-boom simulation	on using
shock tubes	
	A74-16384
Preliminary wind tunnel noise measurements semi-span wing with an upper-surface blo	UI d wn=flan
[AIAA PAPER 74-191]	A74-18832
Computer prediction of aircraft noise	
	A74-19051
Aerodynamic and noise measurements on a qu	asi-two
dimensional augmentor wing model with lo	De-type
nozzles [NASA-TM-X-62237]	N74-13719
[BROW-ID-W-OESOL]	

Takeoff and landing performance and noise measurements of a deflected slipstream ST(
measurements of a deflected slipstream ST()L
airplane with interconnected propellers as	pd
rotating cylinder flaps	
г w a s a - т м - т - 62 3 2 0 1	#74-1372C
Noise demeration by cylindrical spoilers imp	mersed
in an air doct analysis or acoustic pe	O#ST
output and directivity patterns of noise	fielā
[AD-767336]	N74-13730
Sonic inlet noise attenuation and performance	ce with
a J-85 turbojet engine as a noise source	
	N74-14384
	117 17301
a study of the effect of flight density and	
background noise on V/STOL acceptability	
effective perceived noise level as measur	e or
annoyance	
[##3#_##_ 131]	¥7 4-1476 5
ACOUSTIC PROPERTIES	
Noise generation by cylindrical spoilers in	mersed
in an air duct analysis of acoustic P	ower
output and directivity patterns of noise	field
C ND_ 7673363	N74-17730
Sonic inlet noise attenuation and performan a J-85 turbojet engine as a noise source [MASA-TH-X-71488]	ce with
a 3-85 turboiet engine as a noise source	
C 113 C 3 - TW- T- 71498 1	N74-14384
A study of the effect of flight density and	
harbarand poice on M/S#OI accentability	
background noise on V/STOL acceptability effective perceived noise level as measur	a af
	e or
аппоуавсе	N74-14765
I track on missi	M/4-14/03
ACTUATORS	
US Army helicopter hydraulic servocylinder	
reliability and maintainability investiga	tion
[AD-767243]	N74-13731
ABRIAL RECONNAISSANCE	
A preliminary design of a remotely-controll	ed
glider for a long-line operation	
F. D. 7670707	
	N74-13744
[MD 101013]	N74-13744
ABRODYNAMIC BALANCE	N74-13744
ABRODYNAMIC BALANCE Automatic balancing of an aircraft	
ABRODYNAMIC BALANCE Automatic balancing of an aircraft	N74-13744 A74-17804
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS	
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility	a74-178 04
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility	A74-17804 A74-18693
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist	A74-17804 A74-18693 ics of
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne	A74-17804 A74-18693 ics of
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface	A74-17804 A74-18693 ics of er land
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface	A74-17804 A74-18693 ics of
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABBODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul	A74-17804 A74-18693 ics of ar land A74-18681
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr	A74-17804 A74-18693 ics of ar land A74-18681
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways	174-17804 174-18603 ics of ar land 174-18681
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABBODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANTIELD-ABRO-18)	A74-17804 A74-18693 ics of ear land A74-18681 OB
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABBODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANTIELD-ABRO-18)	A74-17804 A74-18693 ics of ear land A74-18681 OB
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways	A74-17804 A74-18603 ics of ar land A74-18681 on N74-13716 25 deg
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANTIELD-ABRO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex-	A74-17804 A74-18603 ics of ar land A74-18681 on N74-13716 25 deg
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing tet transport model with an ex blowing triple-slotted flap	A74-17804 A74-18603 ics of ar land A74-18681 on N74-13716 25 deg
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing det transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] VISTOL tilt rotor aircraft study. Volume 1	A74-17804 A74-18603 ics of ear land A74-18681 com N74-13716 25 deg ternal N74-13721
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing det transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] VISTOL tilt rotor aircraft study. Volume 1	A74-17804 A74-18603 ics of ear land A74-18681 com N74-13716 25 deg ternal N74-13721
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing det transport model with an ex blowing triple-slotted flap [NASA-TM-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14.	A74-17804 A74-18693 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-ABRO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-X-62197] V/STOL tilt rotor aircraft study, Volume 1 Performance and stability test of A 1-14- Froude scaled Boeing Vertol Bodel 222 til	A74-17804 A74-18693 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANTIELD-ABRO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14- Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1)	A74-17804 A74-18603 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622 t rotor
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing 1et transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Model 222 til aircraft (Phase 1) [NASA-CR-114603]	A74-17804 A74-18693 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 (c: 622 t rotor N74-13727
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANTIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi	A74-17804 A74-18693 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 (c: 622 t rotor N74-13727
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways [CRANTIELD-ABRO-18] Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TM-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Model 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1	A74-17804 A74-18603 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Model 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [VRC-13673]	A74-17804 A74-18693 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 (c: 622 t rotor N74-13727 qation N74-14708
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-162197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [NRC-13673] Drag of supercritical airfoils in transonice	A74-17804 A74-18693 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-ABRO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TM-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Model 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [NBC-13673] Drag of supercritical airfoils in transonic comparison with conventional airfoil	A74-17804 A74-18693 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANFIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-162197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [NRC-13673] Drag of supercritical airfoils in transonice	A74-17804 A74-18693 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 622 t rotor N74-13727 qation N74-14708 flow drag
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways (CRANTIELD-AERO-18) Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-1-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [NRC-13673] Draq of supercritical airfoils in transonic comparison with conventional airfoil coefficients	A74-17804 A74-18693 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708 c flow drag N74-14719
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate freduced length runways [CRANTIELD-ABRO-18] Wind tunnel investigation of a large-scale swept-wing let transport model with an exblowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Model 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investiof the shockless lifting airfoil no. 1 [NRC-13673] Drag of supercritical airfoils in transonic——— comparison with conventional airfoil coefficients Development of techniques to measure in-fli	A74-17804 A74-18693 ics of ar land A74-18681 on N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708 c flow drag N74-14719
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways [CRANFIBLD-AERO-18] Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14- Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [NRC-13673] Draq of supercritical airfoils in transonic comparison with conventional airfoil coefficients Development of techniques to measure in-flid drag of a US Navy fighter airplane and	A74-17804 A74-18603 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708 cflow drag N74-14719
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate fr reduced length runways [CRANFIELD-ABRO-18] Wind tunnel investigation of a large-scale swept-wing let transport model with an ex blowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Bodel 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investi of the shockless lifting airfoil no. 1 [NRC-13673] Drag of supercritical airfoils in transonic comparison with conventional airfoil coefficients Development of techniques to measure in-fli drag of a US Navy fighter airplane and correlation of flight measured drag with	A74-17804 A74-18603 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708 cflow drag N74-14719
ABRODYNAMIC BALANCE Automatic balancing of an aircraft ABRODYNAMIC CHARACTERISTICS Supersonic compressor test facility Calculation of the aerodynamic characterist a wing system moving at subsonic speed ne or smooth water surface Performance characteristics of short haul transport aircraft intended to operate freduced length runways [CRANTIELD-ABRO-18] Wind tunnel investigation of a large-scale swept-wing let transport model with an exblowing triple-slotted flap [NASA-TH-I-62197] V/STOL tilt rotor aircraft study. Volume 1 Performance and stability test of A 1-14. Froude scaled Boeing Vertol Model 222 til aircraft (Phase 1) [NASA-CR-114603] An experimental analysis and buffet investiof the shockless lifting airfoil no. 1 [NRC-13673] Drag of supercritical airfoils in transonic——— comparison with conventional airfoil coefficients Development of techniques to measure in-fli	A74-17804 A74-18603 ics of ar land A74-18681 com N74-13716 25 deg ternal N74-13721 0: 622 t rotor N74-13727 qation N74-14708 cflow drag N74-14719

A quick look at the state-of-the-art in		Concepts for a theoretical and experimental study
testing of certain aerodynamic parame	eters	of lifting rotor random loads and vibrations
related to wind tunnel testing [PFA-AU-966]	N76-46300	(identification of lifting rotor system
Concepts for a theoretical and experime	N74-14740	parameters from transient response data), Phase 7-8
of lifting rotor random loads and wit	orations,	[HASA-CR-114710] N74-14758
Phase 2	-	Concepts for a theoretical and experimental study
f NASA-CR-114708]	N74-14756	of lifting rotor random loads and wibrations
Concepts for a theoretical and experime of lifting rotor random loads and wil	ental study	(further experiments with progressing/regressing rotor flapping modes), Phase 7-C
(the effects of some rotor feedback s	systems on	[NASA-CR-114711] N74-14759
rotor-body dynamics), Phase 7-A		ABRODINAMIC DRAG
[NASA-CR-114709]	N74-14757	Profile drag at the drage-rise condition of
Comparison of the flying qualities of t aircraft with the requirements of MII	the A-/D I-R-87858 ASC	<pre>aerofoils having a specified form of upper-surface pressure distribution at this</pre>
[AD-768390]	N74-14768	condition
AEBODYNAMIC COEPPICIENTS		[ESD0-67011] B74-14701
Profile drag at the drage-rise condition aerofoils having a specified form of		Aerodynamic Drag
upper-surface pressure distribution a	at this	[AGARD-CP-124] 974-14709 Technical Evaluation report application of
condition	10 0015	aerodynamic drag research to design of aircraft
[ESDU-67011]	N74-14701	N74-14710
Appendix: A data item service for airc estimation collection, disseminat	raft drag	A survey of drag prediction techniques applicable
development of aerodynamic drag predi	ction data	to subsonic and transonic aircraft design #74-14711
	N74-14717	On some basic and new aspects about the drag
Transonic drag due to lift of planar je	t-flapped	problem of wings and bodies in supersonic flows
airfoils	N7# - 46730	x74-14713
AERODYNAMIC CONFIGURATIONS	N74-14720	Measurements of the drag of some characteristic aircraft excrescences immersed in turbulent
YF-16 stresses advanced technology	design of	boundary layers
lightweight fighter		N74-14714
Improvement of the downflow conditions	A74-16793	Problems of estimating the drag of a helicopter
integrated shrouded propeller	bening an	correlation of flight test data and scale model test data
	A74-17801	N74-14715
March 1971 wind tunnel tests of the Dor	and DH 2011	Aircraft drag prediction for project appraisal and
det flap rotor, volume 1 FRASA-CR-1146931	N74-13722	performance estimation
March 1971 wind tunnel tests of the Dor	and DH 2011	N74-14716 Appendix: A data item service for aircraft drag
jet flap motor, volume 2		estimation collection, dissemination, and
[NASA-CR-114694]	N74-13723	development of aerodynamic drag prediction data
Developmental design, fabrication, and acoustic suppressors for fans of high	test of	974-14717
turbofan engines	. nypass	Remarks on methods for predicting viscous drag aerodynamic drag prediction for high angles of
[NASA-CR-2338]	N74-13724	attack and multielement airfoils
STOL tactical aircraft investigation.	Volume 2:	N74-14718
Design compendium [AD-767561]	N74-13733	Drag of supercritical airfoils in transonic flow
STOL tactical aircraft investigation.	Volume 4:	comparison with conventional airfoil drag coefficients
Wind tunnel data analysis		N74-14719
[AD-767363] Profile drag at the drage-rise conditio	N74-13734	Transonic drag due to lift of planar jet-flapped
aerofoils having a specified form of	on or	airfoils
upper-surface pressure distribution a	t this	N74-14720 Comparison of various methods for calculating
condition		profile drag from pressure measurements in the
[ESDU-67011] Technical Evaluation report applica	N74-14701	near wake at subcritical speeds
aerodynamic drag research to design o	f aircraft	N74-14721
	N74-1471C	Drag and separation effects of separated flow on aerodynamic drag
Measurements of the drag of some charac	teristic	N74-14722
aircraft excrescences immersed in tur boundary layers	bulent	New investigations for reducing the base drag of
	N74-14714	wings with a blunt trailing edge effects of splitter plates and splitter wedges on
Remarks on methods for predicting visco	us drag	aerodynamic drag coefficients
aerodynamic draq prediction for high attack and multielement airfoils	angles of	M74-14723
actack and multielement alrioits	N74-14718	Assessment of the influence of inlet and
New investigations for reducing the bas	0/4-14/10 e drag of	aftbody/nozzle performance on total aircraft drag
wings with a blunt trailing edge	effects of	H74-14726 The problem of installing a modern high bypass
splitter plates and splitter wedges o aerodynamic drag coefficients	D.	engine on a twin jet transport aircraft
acroadramic diad conflictents	N74-14723	N74-14727
Drag of lifting bodies for pilots at his	gh altitude	The drag of externally carried stores: Its prediction and alleviation drag reduction by
	N74-14731	redesign or development of new aircraft
Development of techniques to measure in- drag of a US Navy fighter airplane an	-fliqht	installations
correlation of flight measured drag w	u ith wind	N74-14729
tunnel data		Drag in hypersonic rarefied flow effects of cold pressure drag and friction drag
tonody-nair nameta is it	N74-14734	π74-1473C
Aerodynamic aspects of the problems of and exhaust for a supersonic transpor-	alr-intakes	Drag of lifting bodies for pilots at high altitude
design of air intake and after ho	dy of jet	N74-14731 Development of techniques to measure in-flight
engine for Concorde aircraft		drag of a US Navy fighter airplane and
[NAL-TR-194] Concepts for a theoretical and experimen	N74-14748	correlation of flight measured drag with wind
of lifting rotor random loads and wib	ntal SCUQY	tunnel data 🔨 🖊
Phase 1		174-14734
[NASA-CR-114707]	N74-14755	

SUBJECT INDEX

Review of drag measurements from flight tes	sts of	ARROMAUTICAL ENGINEERING The institute for Flight Mechanics, Braunso	hweia
manned aircraft with comparisons to wind-	tunnel	(081) and Stuttgart (027)	
predictions	N74-14735	[NASA-TT-F-15197]	N74-13706
- 4 6 1.73.1. 3		APPARAGETCAT SAFRILTERS	
Performance of a ballute decelerator towed	Denting	puture sin traffic control = Ground, COCKPL	t, or
a jet airplane	N74-14760	space system functions transfer to ai	rcraft
(NASA-TM-X-56019] ARRODYNAMIC FORCES		or satellites	
Dynamic creep of titanium alloy with 1.5 w	. % Mn	STAY PRECE /4-502	A74-18669
and 3% Al in high-velocity air streams	. ,	ABROSPACE SCIENCES	
did 3% al 2m alqui (12001)	A74-16579	Deutsche Forschungs- und Versuchsanstalt fu	eL
Lifting-surface théory for an oscillating	r-tail	Luft- und Raumfahrt, Annual Report 1972 -	
	A /4-1/012	German book	A74-17969
herodynamic forces and moments on a slender	r body	Merotechnology in aviation problems	
with a jet plume for angles of attack up	ta 180	Metofecunotoda in Maigricus biopiems	N74-14675
degrees	174-18776	AEROSPACE VEHICLES	
[AIAA PAPER 74-110]		Section 3: Stability, construction materia	ls,
A study of the nonlinear aerodynamics of be nonplanar motion numerical analysis	outes in	construction methods	
aerodynamic force and moment systems dur	ing ,		N74-1467C
large amplitude, arbitrary motions		APTERBODIES	
[NASA-TR-R-421]	N74-14741	Aerodynamic aspects of the problems of air-	intakes
Concepts for a theoretical and experimenta	1 study	and exhaust for a supersonic transport an	f dot
of lifting rotor random loads and wibrat.	ions,	design of air intake and after body of)T ler
Phase 2		engine for Concorde aircraft	H74-14748
[NASA-CR-114708]	N74-14756	(MAL-TR-194)	1174 (411)
Concepts for a theoretical and experimenta	l study ·	AFTERBURNING Emission of gaseous pollutants by turbojet	engines
of lifting rotor random loads and wibrat	ions	- The Olympus case	•
(the effects of some rotor feedback syst	ens on	- THE OXYMPON OWNS	A74-173 05
rotor-body dynamics), Phase 7-A	N74-14757	AIR CARGO	
[NASA-CR-114709]	077 (415)	Refrigerated containerized transport for	Jumbo'
AERODYNAMIC INTERPRENCE Nonlinear airfoil theory with allowance fo	r ground	jets	_
effects for aerodynamic interference	•		174-17007
problems solution		Restraint procedures for cargo loaded in ve	enicles
	174-17270	to be air transported	N74-13954
Lift-induced wing-tip vortex attenuation		[AD-768172]	M14-13224
[AIAA PAPER 74-38]	A74-18852	AIR FLOW Dynamic creep of titanium alloy with 1.5 w	t % Mn
Investigations concerning wing-fuselage		and 3% Al in high-velocity air streams	
interference in the case of subsonic wel	A74-18897		174-16579
	W.4-1002	Artificial development of an atmospheric b	oundary
ARRODYNABIC LOADS A 300 B static and fatigue tests		laver flow model in a wind tunnel us.	ing wind
A 300 B Static and latitude bosin	∆74-1675 5	flow modulating devices at wind tunnel e	ntrance
APRODYNAMIC NOISE			N74-13701
Jet noise modeling - Experimental study an	d models	The determination of non-symmetric vehicle	
for the noise and turbulence fields		stability parameters from response data	N74-13702
[AIAA PAPER 74-3]	A74-18723	A proposed method for calculating film-coo	
Preliminary wind tunnel noise measurements	ofa	temperatures in gas turbine combustion c	hambers
semi-span wing with an upper-surface blo	Nn-11ap A74-18832	[CRANFIELD-SME-4]	N74-14440
[AIAA PAPER 74-191]		The effects of hypersonic viscous interact	ion on
Aerodynamic and noise measurements on a gu dimensional augmentor wing model with lo	be-type	static stability of slender bodies in si	mulated
nozzles		non-equilibrium flows	
[NASA-TH-X-62237]	N74-13719		N74-14704
AERODYBANIC STABILITY		AIR INTAKES	
The determination of non-symmetric vehicle	•	The effect of inlet distortion on the perf	ormance
stability parameters from response data		and stability of the low-speed spool of	a
	N74-13702	turbofan engine [AIAA PAPER 74-234]	A74-18855
ABRODYBANIC STALLING		AIR NAVIGATION	
Wind tunnel dynamic analysis of an oscilla	tting	Air traffic control long term planning	in
airfoil	A74-18666	Germany	
[AIA'A PAPER 74-259] Nonlinear aerodynamics of aircraft in	11.1.10000		A74-18182
high-angle-of-attack maneuvers			1,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
		AIR PIRACY	
fatal Paper 74-85 l	A74-18765	AIR PIRACY Skyjacking and airport security	•
fatal Paper 74-85 l	A74-18765 radar	Skyjacking and airport security	A74-18100
	radar	Skylacking and airport security The aftermath of a bilacking - Passenger of	A74-18100
[AIAA PAPER 74-85] Analysis of stall flutter of a helicopter	174-18765 radar 1874-13708	Skyjacking and airport security	A74-18100 laims
[AIAA PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall	radar N74-13708	Skyfacking and airport security The aftermath of a hijacking - Passenger of and insurance	A74-18100
[AIAA PAPER 74-65] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynanic stall [NASA-CR-136473]	radar N74-13708 N74-13709	Skylacking and airport security The aftermath of a bilacking - Passenger of and insurance AIR POLLUTION	A74-18100 laims A74-18101
[AIAA PAPER 74-85] Analysis of stall flutter of a helicopter blade [MASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of	radar N74-13708 N74-13709 the	Skyjacking and airport security The aftermath of a bijacking - Passenger cand insurance AIR POLLUTION Buission of gaseous pollutants by turbojet	A74-18100 claims A74-18101 engines
[AIAA PAPER 74-85] Analysis of stall flutter of a helicopter blade [MASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning sys	radar м74-13708 м74-13709 the tem	Skylacking and airport security The aftermath of a bilacking - Passenger of and insurance AIR POLLUTION	A74-18100 laims A74-18101
[ATMA PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of anral angle of attack/stall warning systan-767663]	radar N74-13708 N74-13709 the	Skyjacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Buission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and	A74-18100 claims A74-18101 engines A74-17305
[AIRA PAPER 74-85] Analysis of stall flutter of a helicopter blade [MASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning system [AD-767653] APPROVEMENTS	radar N74-13708 N74-13709 the tem N74-13748	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Pmission of gaseous pollutants by turbojet - The Olympus case	A74-18100 laims A74-18101 engines A74-17305
[AIAA PAPER 74-85] Analysis of stall flutter of a helicopter blade [MASA-CR-2322] Dynamic stall [MASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning systan-767663] AERODYNAMICS The institute for Flight Mechanics, Braum	radar N74-13708 N74-13709 the tem N74-13748 schweig	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Phission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models	A74-18100 laims A74-18101 engines A74-17305
[AIRA PAPER 74-85] Analysis of stall flutter of a helicopter blade [MASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning system [AD-767653] APPROVEMENTS	radar N74-13708 N74-13709 the tem N74-13748	Skyjacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Buission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and	A74-18100 claims A74-18101 engines A74-17305
[AIAA PAPER 74-65] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning systan-767653] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROBLASTICITY	radar N74-13708 N74-13709 the tem N74-13748 schweig	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Puission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants	A74-18100 claims A74-18101 cengines A74-17305 A74-17312 A74-18180
[ATAN PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of anral angle of attack/stall warning system [AD-767663] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197]	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706	Skyjacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Pmission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically	A74-18100 claims A74-18101 cengines A74-17305 A74-17312 A74-18180
[AIAA PAPER 74-65] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning system [AD-767663] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROELASTICITY Control of an elastic aircraft	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Emission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen	A74-18100 claims A74-18101 cengines A74-17305 A74-17312 A74-18180
[ATMA PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning systance of aural angle of aural aural (027) [NASA-TT-F-15197] ABROBLASTICITY Control of an elastic aircraft	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271 of a low	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Buission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen [AIAA PAPER 74-160]	A74-18100 claims A74-18101 cengines A74-17305 A74-17312 A74-18180 reduce A74-18797
[ATMA PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning systan-767663] AERODYNAMICS The institute for Flight Hechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROELASTICITY Control of an elastic aircraft Transonic single-mode flutter and buffet aspect ratio wing having a subsonic air	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271 of a low foil shape	Skyjacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Puission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen [AIAA PAPER 74-160] Turbojet aircraft engine test cell pollutions	A74-18100 claims A74-18101 cengines A74-17305 A74-17312 A74-18180 reduce A74-18797
[AIAA PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning sys: [AD-767663] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROBLASTICITY Control of an elastic aircraft Transonic single-mode flutter and buffet aspect ratio wing having a subsonic air	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271 of a low foil shape N74-14631	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Buission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen [AIAA PAPER 74-160]	A74-18100 claims A74-18101 cengines A74-17305 A74-17312 A74-18180 reduce A74-18797
[ATAN PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning system [AD-767663] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROBLASTICITY Control of an elastic aircraft Transonic single-mode flutter and buffet aspect ratio wing having a subsonic air [NASA-TK-D-7346] Similarity requirements for aeroelastic assistance of the state of the	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271 of a low foil shape N74-14631	Skylacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Emission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen [AIAA PAPER 74-160] Turbojet aircraft engine test cell pollutionates	A74-18100 claims A74-18101 engines A74-17305 A74-17312 A74-18180 reduce A74-18797 ion
[ATMA PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning systan-767663] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROELASTICITY Control of an elastic aircraft Transonic single-mode flutter and buffet aspect ratio wing having a subsonic air [NASA-TM-D-7346] Similarity requirements for aeroelastic a helicopter rotors	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271 of a low foil shape N74-14631	Skylacking and airport security The aftermath of a hijacking - Passenger of and insurance AIR POLLUTION Emission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen [AIAN PAPER 74-160] Turbojet aircraft engine test cell pollutionate abatement study [AD-768287] Atmospheric Pollution by Aircraft Engines [AGARD-CP-125]	A74-18100 claims A74-18101 engines A74-17305 A74-17312 A74-18180 reduce A74-18797
[ATAN PAPER 74-85] Analysis of stall flutter of a helicopter blade [NASA-CR-2322] Dynamic stall [NASA-CR-136473] The design, fabrication and evaluation of aural angle of attack/stall warning system [AD-767663] AERODYNAMICS The institute for Flight Mechanics, Braum (081) and Stuttgart (027) [NASA-TT-F-15197] AEROBLASTICITY Control of an elastic aircraft Transonic single-mode flutter and buffet aspect ratio wing having a subsonic air [NASA-TK-D-7346] Similarity requirements for aeroelastic assistance of the state of the	radar N74-13708 N74-13709 the tem N74-13748 schweiq N74-13706 A74-18271 of a low foil shape N74-14631 odels of	Skyjacking and airport security The aftermath of a bijacking - Passenger of and insurance AIR POLLUTION Pmission of gaseous pollutants by turbojet - The Olympus case Stratosphere contamination by aircraft and mathematical models Aviation fuels and lubricants The jet engine design that can drastically oxides of nitrogen [AIAA PAPER 74-160] Turbojet aircraft engine test cell pollutinabatement study [AD-768287] Atmospheric Pollution by Aircraft Engines	A74-18100 claims A74-18101 engines A74-17305 A74-17312 A74-18180 reduce A74-18797 ion

AIR TO AIR MISSILES

United States Department of Transportation research program for high altitude pollution	
	Field evaluation of ARTS 2 B (TRACAB)
	evaluation of radar beacon for air traffic
N74-14273	control applications
Photo-oxidation of aircraft engine emissions at	[AD-768203] N74-14360
low and high altitudes	User's manual for ILSLOC: Simulation for
N74-14277	derogation effects on the localizer portion of
Effect of supersonic transport upon the ozone	the instrument landing system
layer, studied in a two-dimensional	[AD-768049] N74-14361
photochemical model with transport	Empirical assessment of ATCRBS performance of
N74-14278	air traffic control digital processing system
Problems of chemical pollution by aircraft. The	[ATC-16] N74-15379
airport and its immediate environment	AIR TRABSPORTATION
N74-14281	United States Department of Transportation
Relative air pollution emissions from an airport	research program for high altitude pollution
in the UK and neighbouring urban areas	R74-14273
N74-14282	Economics of air transport direct and indirect
Pollution levels at London (Heathrow) Airport and	costs
methods for reducing them	[NASA-TT-F-15249] #74-14682
N74-19284	AIRBORNE EQUIPMENT
Pollution control of airport engine test facilities	Airborne profiling of ice thickness using a short
N74-14285 Pactors controlling pollutant emissions from gas	pulse radar
turbine engines	A74-17810
N74-14292	AIRBORNE/SPACEBORNE COMPUTERS
A systematic approach to the study of the	Problems in data management for earth monitoring
connection between emission and ambient air	Missions [BCID DADED 72_100]
Concentrations	[DGLR PAPER 73-109] A74-17205 Data acquisition, processing, and control for
N74-14293	advanced aircraft
A preliminary study on the influence of fuel	[SAE PAPER 730957] A74-17542
staging on nitric oxide emissions from gas	Plight control Computerized aircraft quidance
turbine combustors	A74-18181
x74-14301	AIRCRAFT
The effect of water injection on mitric oxide	Plight control of airplanes and helicopters
emissions of a gas turbine combustor burning	[AD-767943] 874-13738
ASTM Jet-A fuel	AIRCHAPT ACCIDENTS
[NASA-TH-X-2958] N74-14650	Government responsibility for damages in airplane
Effect of water injection on mitric oxide	crash cases when weather is a factor
emissions of a gas turbine combustor burning	A74-18098
natural gas fuel	Orientation-error accidents in regular Army OH-1
[NASA-TE-X-2950] 874-14651	aircraft during fiscal year 1970: Relative
Technical evaluation report on AGARD Technical Meeting on Atmospheric Pollution by Aircraft	incidence and cost
Engines requirement to analyze contribution	[AD-769307] N74-13742
to air pollution near airports from various	AIRCRAFT BRAKES
sources	Recent studies of tire braking performance for aircraft
(AGARD-AR-63) N74-15349	A74-17898
The divided combustion chamber concept and design	AIRCRAFT CARRIERS
	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] N74-13739
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] N74-13739
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] N74-15468	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Bffect of increased fuel temperature on emissions	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] N74-13747
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a boblinear pilot model [AD-767679] AIRCRAFT COMPIGURATIONS
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-X-2931]	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] N74-13739 The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] N74-13747 AIRCRAFT COMPIGURATIONS Pixed wing aircraft
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-X-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] N74-13739 The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] N74-13747 AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] N74-15659 AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a boblinear pilot model (AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TM-X-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIM PAPER 74-186] A74-18841
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TM-X-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] N74-13739 The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] N74-13747 AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] A74-18841 Assessment of the influence of inlet and
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22]	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767693) ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations (ATA-18841 Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] N74-15659 AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLF PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22]	AIRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] N74-13739 The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] N74-13747 AIRCRAFT COMPIGURATIONS Pixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] A74-18841 Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPFIC CONTROL	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a bonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TH-X-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-221] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AT4-16756 AIB TRAPPIC COMTROL The impact of area navigation on flight control	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-068] A74-17177 Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC COMTROL The impact of area nayigation on flight control systems and displays	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a bonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag M74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft M74-14727 The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations (ATA-18176) Assessment of the influence of inlet and afthody/nozzle performance on total aircraft drag modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TH-X-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-221] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC COMTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a boblinear pilot model (AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft A74-18176 Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations (ATA PAPER 74-186] Assessment of the influence of inlet and aftbody/hozzle performance on total aircraft drag modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-068] A74-17177 Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC COMTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a bonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIMA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft P74-14727 The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag mensurements from flight tests of
The divided combustion chamber concept and design for control of SI engine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft A74-18176 Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIMA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag M74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations R74-14729 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-068] A74-17177 TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-221] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC COMTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767679] ATRCRAFT COMPIGURATIONS Pixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [ATAM PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM let-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-1727 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691) The simulation and analysis of carrier landings using a bonlinear pilot model (AD-767679) AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations (AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag mensurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TH-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-068] TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURPACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a boblinear pilot model [AD-767693] ATRCHAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAM PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions N74-14725 Exhaust system interaction program evaluation
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM let-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPFIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vortex cases - At a turbulent crossroads	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model (AD-767693) ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations (ATAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations M74-14729 Review of drag mensurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions M74-14735 Exhaust system interaction program evaluation of exhaust system installation losses and effect
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM let-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPFIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vortex cases - At a turbulent crossroads	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a bonlinear pilot model [AD-767679] AIRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft mr4-14727 The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions N74-14735 Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TH-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects A74-18050 Vorter cases - At a turbulent crossroads aircraft wakes and legal liability for accidents	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767693] ATRCHAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAM PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086]
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TH-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects A74-18050 Vorter cases - At a turbulent crossroads aircraft wakes and legal liability for accidents	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [ATAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086] Pight test data for a Cessna Cardinal steady
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM let-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker A74-16756 AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vorter cases - At a turbulent crossroads aircraft wakes and legal liability for accidents	ATRICRATT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a bonlinear pilot model [AD-767679] ATRICRATT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag mensurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions N74-14735 Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086] P14-14747 Plight test data for a Cessna Cardinal steady state performance and fixed stick dynamic
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM Tet-A fuel [NASA-TH-X-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAFFIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vorter cases - At a turbulent crossroads aircraft wakes and legal liability for accidents A74-18097 Air traffic control long term planning in Germany	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a boblinear pilot model [AD-767693] ATRCHAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAM PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag m74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086] Plight test data for a Cessna Cardinal steady state performance and fixed stick dynamic stability characteristics
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM let-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vortex cases - At a turbulent crossroads aircraft wakes and legal liability for accidents A74-18097 Air traffic control long term planning in Germany A74-18182 Future air traffic control - Ground, cockpit, or	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767693] ATRCRAFT COMPIGURATIONS Fixed wing aircraft AP4-18176 Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [ATAM PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag my4-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations **M74-14729** Review of drag mensurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions **M74-14735** Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086] Plight test data for a Cessna Cardinal steady state performance and fixed stick dynamic stability characteristics [MASA-CR-2337]
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Wilitary and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vortex cases - At a turbulent crossroads aircraft wakes and legal liability for accidents A74-18097 Air traffic control long term planning in Germany A74-18182 Future air traffic control - Ground, cockpit, or space system functions transfer to aircraft	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system [AD-767691] The simulation and analysis of carrier landings using a bonlinear pilot model [AD-767679] ATRCRAFT COMPIGURATIONS Fixed wing aircraft Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag N74-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations N74-14729 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions N74-14735 Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086] Plight test data for a Cessna Cardinal steady state performance and fixed stick dynamic stability characteristics [NASA-CR-2337] AIRCRAFT CONTROL
The divided combustion chamber concept and design for control of SI enqine exhaust air pollutant emissions N74-15454 Reduction of pollutants from aircraft turbine by fuel selection and prevaporization [AD-769099] Effect of increased fuel temperature on emissions of oxides of nitrogen from a gas turbine combustor burning ASTM let-A fuel [NASA-TM-x-2931] AIR TO AIR MISSILES Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] TWO numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] AIR TO SURFACE MISSILES Lasers - Ranger and marked target seeker AIB TRAPPIC CONTROL The impact of area navigation on flight control systems and displays A74-17277 Innovations in ATC communication systems since 1920's Military and aerospace cost effective technology utilization for ATC, NASA programs and defense projects Vortex cases - At a turbulent crossroads aircraft wakes and legal liability for accidents A74-18097 Air traffic control long term planning in Germany A74-18182 Future air traffic control - Ground, cockpit, or	ATRCRAFT CARRIERS A modified design concept, utilizing deck motion prediction, for the A-7E automatic carrier landing system (AD-767691] The simulation and analysis of carrier landings using a nonlinear pilot model [AD-767693] ATRCRAFT COMPIGURATIONS Fixed wing aircraft AP4-18176 Application of an improved unified subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft configurations [ATAM PAPER 74-186] Assessment of the influence of inlet and aftbody/nozzle performance on total aircraft drag my4-14726 The problem of installing a modern high bypass engine on a twin jet transport aircraft The drag of externally carried stores: Its prediction and alleviation drag reduction by redesign or development of new aircraft installations **M74-14729** Review of drag mensurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions **M74-14735** Exhaust system interaction program evaluation of exhaust system installation losses and effect on aircraft performance [AD-769086] Plight test data for a Cessna Cardinal steady state performance and fixed stick dynamic stability characteristics [MASA-CR-2337]

SUBJECT INDEX

Decompling of a class of monlinear systems and its	Computer program to perform cost and weight
application to an aircraft control problem	analysis of transport aircraft. Volume 1: Summary
A74-18139 Control of an elastic aircraft	INASI-CR-1323617 N74-14762
174-18271	computer program to perform cost and weight
Tactile display for aircraft control	analysis of transport aircraft. Volume 2:
[AD-767763] 874-13741	Technical volume [NASA-CR-132362] N74-14763
à computer program for aircraft optimal control problems	ATROPAPT RUGIURS
[AD-767919] N74-13750	Noise and emission outlook for military engines
A real-time digital program for estimating	[AIRA PAPER 73-1156] A74-171/5 An approach toward optimizing material cost and
aircraft stability and control parameters from	part function in advanced powerplants
flight test data by using the maximum likelihood method	rsar paper 7309091 A74-17535
[NASA-TM-I-2788] N74-13882	Heat-resistant titanium alloys - Introduction of
Application of the aerospace multiprocessor to the	the 651 A alloy A74-17891
A-7D flight control system development of digital fly-by-wire system	Propulsion system installations for aircraft
[AD-768382] N74-14769	A/4-181/9
AIRCRAPT DESIGN	Importance of the means of engine condition surveillance
Manufacturing exercise involved in the redesign of	A74-18598
the Hawker Siddeley Trident /tri-jet/ fuselage 174-16445 B-1 cost/weight trade methodology	Some specific characteristics of small gas turbines and the modeling problems of their wind
A74-16947	tunnel testing
YF-16 stresses advanced technology design of	A74-18682
lightweight fighter	<pre>Photo-oxidation of aircraft engine emissions at low and high altitudes</pre>
Transonic transport wings - Oblique or swept	N74-14277
A74-17048	Effect of supersonic transport upon the ozone
Design and hover-flight testing of a deflection	layer, studied in a two-dimensional photochemical model with transport
control system for the Aerodyne wingless, remote-controlled experimental flight vehicle	N74-14278
[DGLE PAPER 73-070] A74-17179	Technology for the reduction of aircraft turbine
Automatic control aspects of a control-configured	engine exhaust emissions N74-1430(
aircraft with allowance for maneuver load control [DGLR PAPER 73-121] 174-17216	Design and evaluation of combustors for reducing
Materials for the new generation of aircraft	aircraft engine pollution
A74-17374	N74-14302
L-1011 upkeep (SAR PAPER 730883) A79-17532	Aircraft qas turbine pollutant limitations oriented toward minimum effect on engine
[SAE PAPER 730803] Development of requirements for, and evaluation	performance
of, manufacturer advanced design aircraft	N74-14304
[SAR PAPER 730948] A74-17541	Technical evaluation report on AGARD Technical Meeting on Atmospheric Pollution by Aircraft
Utility analysis in weight control	Engines requirement to analyze contribution
Vehicle crashworthiness rotary wing, fixed	to air pollution near airports from various
wing light and transport aircraft	sources (AGARD-AR-631 N74-15349
A74-17776	[AGARD-AR-63] The divided combustion chamber concept and design
New jumbo jets must speak in whispers - Certifying the Lockheed 1011	for control of SI engine exhaust air pollutant
A74-17856	emissions n74-15454
Aircraft components from remelted steels - Design	AIRCRAPT EQUIPMENT
and development a74+17887	Theory and practice of avionics reliability
Automatic flight controls in fixed wing aircraft -	A74-18597
The first 100 years	Plight study of a wehicle operational status and monitoring system applied to systems on
A74-18296 Application of damage tolerance technology to	YF-12 aircraft
advanced metallic fighter wing structure	[NASA-IN-D-7546] N74-13725
[AIAA PAPER 74-29] A74-18738	Failure analysis of helicopter external
Methods for the design and analysis of jet-flapped airfoils	cargo-handling systems [AD-767254] N74-13729
[AIAA PAPER 74-188] A74-18833	The ac power controllers for solid state
Thin-airfoil theory of an ejector-flapped wing	distribution system. Volume 1: Design,
section [AIAA PAPER 74-187] A74-18834	development, fabrication, and test of hybrid devices
Multi-surface system for the CCV B-52 Control	[AD-768199] N74-13903
Configured Vehicles	Aircraft inertial system testing and evaluation in
[AIAA PAPER 74-126] A74-18851 The Alpha Jet programme	the United Kingdom
174-18902	Analysis and calculation of lightning-induced
A preliminary design of a remotely-controlled	voltages in aircraft electrical circuits [NASA-CR-2349] N74-1475
qlider for a long-line operation [AD-767879] B74-13744	AIRCHAPT FUEL SISTEMS
Technical Evaluation report application of	Models in the design of fuel systems
aerodynamic drag research to design of aircraft	A74-16758 Automatic balancing of an aircraft
N74-14710 A survey of drag prediction techniques applicable	Automatic datascing of an afforait
to subsonic and transonic aircraft design	AIRCRAFT FUELS
¥74-14711	The hydrogen fuel economy and aircraft propulsion [AIAA PAPER 73-1319] A74-1790
Aircraft drag prediction for project appraisal and performance estimation	[AIAA PAPER 73-1319] A74-1790! Aviation fuels and lubricants
performance escimation R74-14716	174-1818
The problem of installing a modern high bypass	AIRCRAPT GUIDABCE Plight control computerized aircraft guidance
engine on a twin jet transport aircraft N74-14727	A74-1818
	•

A74-16446

Blectronic displays and digital automatic control	Microwave Landing System (MLS) development plan as
in advanced terminal area operations	proposed by Maytheon during the technique
[AIAA PAPER 74-27] A74-18881	analysis and contract definition phase of the
Calculation and analysis of aircraft motion various quidance methods and numerical solution	national MLS development program. Volume 6:
of optimal control theory problems	Supporting studies, appendices D through N [PAA-RD-73-150-6-APP-D-N] N74-15386
[NASA-TT-F-757] N74-14751	[FAA-HD-/3-150-6-APP-D-N] R74-15386 AIRCHAPT MAISTENANCE
AIRCRAFT HAZARDS	Avionics design for maintainability - Are we
Vortex age as a wake turbulence scaling parameter	qaining or losing
[AIAA PAPER 74-36] A74-18745 AIRCRAFT INDUSTRY	[SAE PAPER 730882] A74-17531
Aviation needs and public concerns civil	L-1011 upkeep [SAE PAPER 730883] A74-17532
aviation growth in Europe and environmental	[SAE PAPER 730883] A74-17532 Aircraft and systems reliability relation to
control	overhaul and maintenance
N74-14749	174-18599
AIRCHAPT INSTRUMENTS The Type 3B altitude measurement system	T700 aims at low combat maintenance turboshaft
A74-17276	engine for military transports and helicopters
AIRCRAFT LANDING	A74-18998 Hajor Item Special Study (HISS), AH-16 driveshaft
An analytic approximate calculation of the	assembly, main transmission to engine
nonlinear landing impact motions and loads on	[AD-768763] R74-14780
aircraft with both rigid and elastic wing structure	Helicopter inspection design requirements
[DGLR PAPER 73-078] A74-17185	[AD-769061] N74-14781 Major Item Special Study (MISS), AH-1G mast assembly
Air traffic control long term planning in	failure analysis of helicopter antenna mast
Germany	assembly
A74-18182 Influence of boundary layer blowing on the	[AD-768764] H74-14782
low-speed aerodynamic performance of a 45 degree	AIRCRAFT MANEUVERS
swept-wing airplane	Automatic control aspects of a control-configured aircraft with allowance for maneuver load control
[AIAA PAPER 74-269] A74-18674	[DGLE PAPER 73-121] A74-17216
A modified design concept, utilizing deck motion	Differential-turning optimality criteria for
prediction, for the A-7E automatic carrier landing system	aircraft pursuit/evasion situations
[AD-767691] N74-13739	[AIAA PAPER 74-23] A74-18737 Monlinear aerodynamics of aircraft in
The simulation and analysis of carrier landings	high-angle-of-attack maneuvers
using a nonlinear pilot model	[AIAA PAPER 74-85] A74-18765
[AD-767679] N74-13747 Hicrowave Landing System (MLS) development plan as	AIBCRAPT MODELS
proposed by All during the technique analysis	Decoupling of a class of nonlinear systems and its
and contract definition phase of the national	application to an aircraft control problem
HLS development program, Part 1.0, Volume 1.1:	174-18139 Relicopter modelling /18th Henson and Stringfellow
Technique analysis program	Lecture/ exploratory, development and
[PAA-RD-73-166-VOL-1.1] N74-14340 Bicrowave Landing System (MLS) development plan as	research models
proposed by AIL during the technique analysis	ATRCHAPT MOISE
and contract definition phase of the mational	Noise burden factor - New way of rating airport
MLS development program, Part 1,0, Volume 1,2,	noise
Book 1: Post TACD development plan [FAA-RD-73-166-VDL-1.2,1-BK-1] B74-14341	A74-16898
Hulti-input, multi-output regulator design for	Putting all our noise technology to work WASA
constant disturbances and non-zero set points	Quiet Bngine Program
with application to automatic landing in a	Vertical take-off and landing aircraft
Crosswind [NASA-CR-136618] N7H-15378	17D-18178
Pailure modes, effects and criticality analysis	The German law for protection against the noise of
(PMECA) of category III instrument landing	aircraft
system with traveling: Wave localizer antenna	174-18265 Isolated airfoil - TIP wortex interaction noise
[U1-840912-100] B74-15360	[AIAA PAPER 74-194] A74-18831
Microwave Landing System (MLS) development plan as proposed by Raytheon during the technique	Computer prediction of aircraft noise
Analysis and contract definition phase of the	A74-19051
national MLS development program. Volume 1:	Aerodynamic and noise measurements on a quasi-two dimensional augmentor wing model with lobe-type
Elecutive summary	nozzles
[FAA-RD-73-150-1] N74-15381 Microwave Landing System (MLS) development plan as	[NASA-TH-X-62237] N74-13719
proposed by Raytheon during the technique	Takeoff and landing performance and noise
analysis and contact definition phase of the	<pre>measurements of a deflected slipstream STOL airplane with interconnected propellers and</pre>
national HL5 development program, Volume 3:	rotating cylinder flaps
1.1.1 performance validation [PAA=RD=73=15C=3] N7D=45202	[NASA-TH-I-623201 H74_13720
Hicrowave Landing System (HLS) development plan as	Developmental design, fabrication, and test of
PIOPOSED DY Raytheon during the technical	accustic suppressors for fans of high bypass
abalysis and contract definition phase of the	turbofan engines [NASA-CR-2338] N74-13724
national BLS development program, Volume 31	[RASA=CR-2338] W74-13724 Hilitary aircraft and airport noise and
[PAA-RD-73-150-3A] H74-15383	opportunities for reduction without inhibition
Sicrovave Landing System (SLS) development plan as proposed by Raytheon during the technique	of military missions
analysis and contract definition where of the	[PB-223637/0Gh] #74-13752
Dational MLS development program Volume to	A study of the effect of flight density and background noise on V/STOL acceptability
System considerations 1.1.2 through 1.1.5	effective perceived noise level as measure of
[714-RD-73-150-4] Hicrovave Landing System (HLS) development plan as	annoyanca
PIOPOSEG DV Havtheon doring the technique	[WASA-CR-2197] #74-14765
APGLYSLE ADD CODITACT definition where of the	AIRCRAFT PARTS The use of ultra high stronger titaning allows in
DELIGIAL DES GEVELOPMent program values 6.	The use of ultra high strength titanium alloys in a V/STOL military mircraft application - The H,
Post TA/CD plans, management performance	S. A. Harrier
1 FAA-RD-73-150-5 1 N74-15385	1043F-1640E

SUBJECT INDEX

	externally
Development of cold headable titanium alloys for	STOL tactical aircraft investigation, externally blown flap, Volume 5, part 3: Stability and
the 'Concorde' supersonic jet	control derivative accuracy requirements and
	effects of augmentation system design
Fretting resistant coatings for titanium alloys A74-16592	FAD=7671821 874-13757
Mircraft components from remelted steels - Design	A real-time digital program for estimating
and development	aircraft stability and control parameters from flight test data by using the maximum likelihood
A74-17887	
Improved circumferential shaft seal for aircraft	method [NASA-TK-X-2788] N74-13882
qear transmissions	The problem of installing a modern high bypass
[NASA-TN-D-7130] N74-14138 AIRCRAFT PERFORMANCE	angine on a twin jet transport aircraft
Tr-16 stresses advanced technology design of	K/4-14/2/
lightweight fighter	Calculation and analysis of aircraft motion
A74-16793	warious quidance methods and numerical solution of optimal control theory problems
Some results of an experimental study of the	f ma < 5 - 97 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 -
Aerodyne concept by Dornier System GmbH [DGLR PAPER 73-069] A74-17178	Flight test data for a Cessna Cardinal steady
[DGLE PAPER 73-069] Influence of boundary layer blowing on the	state performance and fixed stack dynamic
low-speed aerodynamic performance of a 45 degree	stability characteristics
swept-wing airplane	(MADE-CV-2001)
FATAA PAPER 74-2691 A74-18674	AIRCRAFT STRUCTURES Applications of the high strength alloy
Trimmed drag and maximum flight efficiency of aft	Ti-411-4Mo-2Sm-0.5Si in European aircraft projects
tail and canard configurations	1/4-1045C
[AIRA PAPER 74-69] Performance characteristics of short haul	Titanium - The bridge to composites for light
transport aircraft intended to operate from	weight/high performance aircraft A74-16451
reduced length runways	-
CRANFIELD-AERO-181 N74-13716	A 300 B static and fatique tests
The influence of wing loading on turbofan powered	An analytic approximate calculation of the
STOL transports with and without externally	nonlinear landing impact motions and loads on
blown flaps [NASA-CR-2320] N74-13718	aircraft with both rigid and elastic wing
The design and flight evaluation of a performance	structure 374-17185
control system general aviation aircraft	
under VFR conditions	Materials for the new generation of aircraft A74-17374
[AD-767786] B74-13746	Application of advances in structures and
Aerodynamic Drag	materials to the design of the TF-17 airplane
[AGARD-CP-124] Brhaust system interaction program evaluation	f SAR PAPER 7308911 A74-17534
of exhaust system installation losses and effect	The use of fully stressed iteration and structural
on aircraft performance	index in automated structural optimization A74-17739
ran=7690861 \\ \text{\pi}74=14747	An aircraft exterior coating system and surface
Calculation and analysis of aircraft motion various quidance methods and numerical solution	pretreatment
of optimal control theory problems	<u>A74-17862</u>
[NASA-TT-P-757] N74-14751	Structural materials of aeronautics and astronautics
Plight test data for a Cessna Cardinal steady	A74-1819C
state performance and fixed stick dynamic	Analytical design of optimal monolithic panels A74-18642
stability characteristics	On repetitive flutter calculations in structural
[NASA-CR-2337] N/4-14/52 Comparison of the flying qualities of the A-7D	desian
aircraft with the requirements of MIL-P-8785B ASG	FATAA PAPER 74-1411 A74-18789
[AD-768390] B74-14768	An improved exceedance theory for combined random
AIRCRAFT PRODUCTION	stresses with application to aircraft qust
Design and development support for critical	response N74-14569
helicopter applications in Ti-6Al-4V alloy A74-16448	Analytical and experimental investigation of
AIRCHAFT RELIABILITY	aircraft metal structures reinforced with
Aircraft and systems reliability relation to	filamentary composites, Phase 3: Major
overhaul and maintenance	component development
A74-18599	[MASA-CR-2122] W/4-14625 Optimisation of aircraft structures with multiple
AIRCRAFT SAFETY	stiffness requirements
Dynamic test of air data computers with simulated	к74-15612
flight profiles	AIRCRAPT SURVIVABILITY
Vehicle crashworthiness rotary wing, fixed	application of damage tolerance technology to
wing light and transport aircraft	advanced metallic fighter wing structure
174-17776	[AIRA PAPER 74-29] A74-18738 AIRCRAFT TIRES
The Eole balloons and air safety	Recent studies of tire braking performance for
Theory and practice of avionics reliability	aircraft
A74-18597	174-17898
An investigation of pattern recognition of	AIRCRAFT WARBS
aircraft attitudes indicator displays	<pre>Fortex cases - At a turbulent crossroads aircraft wakes and legal liability for accidents</pre>
[AD-768345] H74-14126	A74-18097
AIRCRAFT STABILITY Automatic balancing of an aircraft	Inviscid wake-airfoil interaction on multielement
174-17804	high lift systems
Plight control computerized aircraft quidance	874-18143
A74-18181	A method of calculating aircraft wake velocity
Control Configured Vehicle Ride Control (CCV RCS).	profiles and comparison with full-scale experimental measurements
B-52 control system analysis, synthesis, and	[AIAA PAPER 74-39] A74-18747
design (AD-767590) H74-13728	Ingestion and dispersion of engine exhaust
a pylon to decrease the effects of external stores	products by trailing vortices for supersonic
on the stability of aircraft [AD-767913] N74-13749	flight in the stratosphere [AIAA PAPER 74-42] A74-18815

AIRPOIL PROFILES SUBJECT INDEX

Comparison of various methods for calculating profile drag from pressure measurements in the	Control of an elastic aircraft A74-18271
bear wake at subcritical speeds N74-14721	An algorithm for rational selection of the parameters of nonlinearly deforming thin-walled
AIRFOIL PROPILES	framework elements
A direct method for computing the steady flow at Mach number one past a given wing airfoil	A74-18645 Study of structural criteria for composite
A74-16963	airframes, Volume 1: Evaluation
Calculation of separated flows at subsonic and transonic speeds	[1D-767706] N74-14238 Study of structural criteria for composite
A74-16965	airframes. Volume 2: Current/criteria/selected
A method of designing supercritical lift profiles [DGLR PAPER 73-081] A74-17187	rationale review and evaluation
Characteristics of the wake behind a cascade of	[AD-767707] N74-14239 Structural analysis of light aircraft using WASTRAN
airfoils A74-17495	N74-14594 Static and dynamic helicopter airframe analysis
Wind tunnel dynamic analysis of an oscillating	with MASTRAN
airfoil [AIAA PAPER 74-259] A74-18666	N74-14616
Unsteady lift forces on highly cambered airfoils	NASTRAN data generation of helicopter fuselages using interactive graphics preprocessor
moving through a qust [AIAA PAPER 74-88] A74-18897	system for finite element analysis using IBM computer
Hethods for the design and analysis of jet-flapped	N74-14621
airfoils [AIAA PAPER 74-188] 174-18833	Similarity parameters and their sensitivity for
AIRFOILS	transonic airframe exhaust nozzle interactions [AD-768988] N74-14746
Nonlinear airfoil theory with allowance for ground effects for aerodynamic interference	Helicopter inspection design requirements
problems solution	(AD-769061) N74-14781 AIRLINE OPERATIONS
A74-17270 Integral equation method for calculation of	L-1011 upkeep
subsonic flow past airfoils in a ventilated wind	[SAE PAPER 730883] Development of requirements for, and evaluation
tunnel - Comparison with NAE high Reynolds number weasurements	of, manufacturer advanced design aircraft
[AIAA PAPER 74-83] A74-18764	[SAE PAPER 730948] A74-17541 Skylacking and airport security
Isolated airfoil - TIP vortex interaction noise [AIAA PAPER 74-194] A70-18831	A74-18100
Analysis of flow-reversal delay for a pitching	United States Department of Transportation research program for high altitude pollution
airfoil	M74-14273
TAIAN PAPER 74-183] A74-18835 Transonic single-mode flutter and buffet of a low	AIRPLANE PRODUCTION COSTS 8-1 cost/weight trade methodology
aspect ratio wing having a subsonic airfoil shape	174-16447
[NASA-TN-D-7346] N74-14631 Profile drag at the drage-rise condition of	AIHPORT PLANNING Noise burden factor - New way of rating airport
aerofoils having a specified form of upper-surface pressure distribution at this	noise
condition	A74-16898 An innovative approach to airport planning
[ESD0-67011] 874-14701	A74-18099
An experimental analysis and buffet investigation of the shockless lifting airfoil no. 1	AIRPORTS A new ILS localizer for regional airports
[NRC-13673] Remarks on methods for predicting viscous drag	A74-18901
aerodynamic draq prediction for high angles of	Military aircraft and airport noise and opportunities for reduction without inhibition
attack and multielement airfoils	of military missions
#74-14718 Transonic drag due to lift of planar jet-flapped	[PB-223637/0GA] 874-13752 Problems of chemical pollution by aircraft, The
alriolls	airport and its immediate environment
AIRFRANE MATERIALS H74-14720	#74-14281 Relative air pollution emissions from an airport
The use of ultra high strength titanium alloys in	in the UK and neighbouring urban areas
a V/STOL military aircraft application - The H. S. A. Harrier	#74-14282 Pollution levels at London (Beathrow) hirport and
A74-16446 Effects of Ti-6A1-4V alloy metallurgical	methods for reducing them
structures on ultrasonic response characteristics	N74-14284 Pollution control of airport engine test facilities
ultrasonic inspection of titanium airframe	π74 -1 4285
Components	AIBSPEED Flight velocity effects on jet noise of several
174-16479 High cycle fatique properties of titanium in	variations of a 40-tube suppressor installed on
aircraft application	a plug nozzle [NASA-TH-X-2919] N74-15465
A74-16513 Deep hardenable titanium alloys for large airframe	Plight velocity effects on jet noise of several
elements	<pre>variations of a twelve-chute suppressor installed on a plug nozzle</pre>
A74-16559 Application of advances in structures and	[NASA-TN-X-2918] N74-15466
materials to the design of the YP-17 airplane	ALGORITHMS Bwaluation of the operations contained in
SAE PAPER 730891 176-176-20	algorithms carried out by digital controller
Structural materials of aeronautics and astronautics A74-18190	computers
Experimental study of metal-plastic couplings in tension	A74-18638 An algorithm for rational selection of the
A74-18648	parameters of nonlinearly deforming thin-walled framework elements
AIRPRAMBS Plat rolled beta titanium alloys for airframe	A74-18645
application	ALTIMETERS The Type 3B altitude measurement system
A74-16449 Titanium flamecutting reduces airframe costs	174-17276
A74-16760	

Evaluation of the modified Bendix AAU 19A/A AIMS	Microwave Landing System (MLS) development plan as
altimeter	proposed by Raytheon during the technique
[AD-768722] N74-15115	analysis and contract definition phase of the
ALUMINUM ALLOYS	national MLS development program, Volume 1: Executive summary
Evaluation of methods for reducing fretting	rea-ro-73-150-11 N74-15381
fatique damage in 2024-T3 aluminum lap joints A74-16696	Microwave Landing System (MLS) development plan as
Buckling loads and minimum weight of compressed	proposed by Raytheon during the technique
curved ribbed aluminum alloy panels	analysis and contact definition phase of the
A74-16822	national MLS development program. Volume 3: 1.1,1 performance validation
Heat-resistant titanium alloys - Introduction of	. rpx-pn-73-150-31 N74-15382
the 651 A alloy	Microwave Landing System (MLS) development plan as
ANALOG COMPUTERS	proposed by Raytheon during the technical
Dynamic test of air data computers with simulated	analysis and contract definition phase of the
flight profiles	national MLS development program, Volume 3A
A74-17736	[FAA-RD-73+150-3A] N74-1538. Microwave Landing System (MLS) development plan as
ANALOG DATA	proposed by Raytheon during the technique
Plight study of a vehicle operational status and monitoring system applied to systems on	analysis and contract definition phase of the
IF-12 aircraft	national MLS development program. Volume 4:
[NASA-TN-D-7546] N74-13725	System considerations 1.1.2 through 1.1.5
ANGLE OF ATTACK	[FAR-RD-73-150-4] N74-1538
Supersonic flow past sharp- and blunt-nosed	Microwave Landing System (MLS) development plan as proposed by Raytheon during the technique
conical bodies at angles of attack from 0 to 45	analysis and contract definition phase of the
deq [DGLR PAPER 73-080] A74-17186	national BLS development program, Volume 5:
The jet-flapped wing in ground proximity with	post TA/CD plans, management performance
special allowance for large angle of attack and	[PAA-RD-73-150-5] N74-1538
large jet flap angle	Microwave Landing System (MLS) development plan as
A74-17221	proposed by Raytheon during the technique analysis and contract definition phase of the
Vortex age as a wake turbulence scaling parameter farah paper 74-361 A74-18745	national MLS development program. Volume 6:
[ATAN PAPER 74-36] A74-18745 Nonlinear aerodynamics of aircraft in	Supporting studies, appendices D through N
high-angle-of-attack maneuvers	[FAA-RD-73-150-6-APP-D-N] N74-1538
[AIAA PAPER 74-85] A74-18765	APPROXIMATION
Aerodynamic forces and moments on a slender body	An analytic approximate calculation of the nonlinear landing impact motions and loads on
with a jet plume for angles of attack up to 180	aircraft with both rigid and elastic wing
degrees [ATAA PAPER 74-110] A74-18776	structure
[AIAA PAPER 74-110] Transonic flow about lifting wing-body combinations	[DGLR PAPER 73-078] A74-1718
[AIAA PAPER 74-185] A74-18612	AREA WAVIGATION
Evaluation of aircraft departure divergence	The impact of area navigation on flight control
criteria with a six-degree-of-freedom digital	systems and displays
simulation program [ATAA PAPER 74-68] A74-18882	ARMED FORCES (UNITED STATES)
The design, fabrication and evaluation of the	Airborne warning and control system /AWACS/
aural angle of attack/stall warning system	for air operations management during military
[AD-767663] N74-13748	crises
A study of the nonlinear aerodynamics of bodies in	[AIAA PAPER 74-241] A74-1865 ASPECT RATIO
nonplanar motion numerical analysis of aerodynamic force and moment systems during	Transonic single-mode flutter and buffet of a low
large amplitude, arbitrary motions	aspect ratio wing having a subsonic airfoil shape
[NASA-TR-R-421] N74-14741	[NASA-TN-D-7346] N74-1463
ARTENNA ARRAYS	ASTRIONICS Deutsche Forschungs- und Versuchsanstalt fuer
New concepts in AMTI radar - Nulling effects of	Luft- und Raumfahrt, Annual Report 1972
Doppler filter/multi-element horn array A74-17252	German book
ANTENNA COMPONENTS	A74-1796
Major Item Special Study (MISS), AH-1G mast assembly	ATHOSPHERIC CHEBISTRY
failure analysis of helicopter antenna mast	Atmospheric Pollution by Aircraft Engines [AGARD-CP-125] N74-1427
assembly [an-768764] N74-14782	Reduction of NO formations by premixing
(AD-768764) N74-14782 ANTENNA RADIATION PATTERNS	h74-1427
User's manual for ILSLOC: Simulation for	United States Department of Transportation
derogation effects on the localizer portion of	research program for high altitude pollution N74-1427
the instrument landing system	Photo-oxidation of aircraft engine emissions at
[AD-768049] N74-14361	low and high altitudes
ANTISKID DEVICES Recent studies of tire braking performance for	×74-1427
aircraft	Relative air pollution emissions from an airport
174-17898	in the UK and neighbouring urban areas
ANTISUBBARINE WARFARE AIRCRAPT	N74-1428
The S=3A - A new dimension in airborne sea control	Relative air pollution emissions from an airport
[AIAA PAPER 74-239] A74-19205 APPROACH CONTROL	in the UK and neighbouring urban areas
Microwave Landing System (MLS) development plan as	N74-1428
proposed by All during the technique analysis	Pollution levels at London (Heathrow) Airport and
and contract definition phase of the national	methods for reducing them N74-1428
MLS development program. Part 1.0, Volume 1.1:	Pollution control of airport engine test facilities
Technique analysis program [FAA-RD-73-166-VOL-1.1] N74-14340	N74-1426
Simplified Visual Approach Slope Indicator (VASI)	ATMOSPHERIC DENSITY
operation test and evaluation	A systematic approach to the study of the
FAD-7679011 874-14362	connection between emission and ambient air
Failure modes, effects and criticality analysis	concentrations
(FMECA) of category III instrument landing system with traveling: Wave localizer antenna	
[01-840912-100] N74-15380	. 1

ATROSPHERIC DIPPOSION Dispersion and dilution of jet aircraft exhaus high-altitude flight conditions	st at	ATISTHMETRIC PLON Calculation of potential flow about axially
[AIAA PAPER 74-41] A74	4-18749	symmetric fuselages, annular profiles and engine inlets
ATTOSPHERIC MODELS Artificial development of an atmospheric bound		(RASA-TT-P-15213) 874-13707
layer flow model in a wind tunnel using	wind	Calculation of the boundary-layer flow in the windward symmetry plane of a spherically blunted
flow modulating devices at wind tunnel entra	ance	axisymmetric body at angle of attack, including
N74 A systematic approach to the study of the	4-13701	stream line-swallowing effects [AD-768340] N74-13992
connection between emission and ambient air		
Concentrations N74	4-14293	В
ATHOSPHERIC TEMPERATURE		B-1 AIRCRAFT
Temperature, winds, and turbulence at SST fliq levels	ght '	B-1 cost/weight trade methodology A74-16447
≥ 74	4-17311	Three dimensional supersonic flow field analysis
ATROSPHERIC TURBULENCE Temperature, winds, and turbulence at SST flig		of the B-1 airplane by a finite difference technique and comparison with experimental data
levels	440	[AIAA PAPER 74-189] A74-18877
A74 Control Configured Vehicle Ride Control (CCV R	4-17311	B-52 AIRCRAFT
B-52 control system analysis, synthesis, and	acs,	<pre>Bulti-surface system for the CCV B-52 Control Configured Vehicles</pre>
design [AD-767590] N74	II - 43719	[AIAA PAPER 74-126] A74-18851
The spectrum of turbomachine rotor noise cause	4-13728 ed by	Control Configured Vehicle Ride Control (CCV RCS) B-52 Control system analysis, synthesis, and
inlet quide vane wakes and atmospheric turbu	ulence	design
ATTACK AIRCRAFT	4-14379	[AD-767590] N74-13728 BALLOOW SOUNDING
Lasers - Ranger and marked target seeker		Temperature, winds, and turbulence at SST flight
The Alpha Jet prograpme	4-16756	levels A74-17311
λ74	4-18902	BALLOOMS
ATTITUDE INDICATORS An investigation of pattern recognition of		LDF powered balloon program feasibility demonstration of free balloon station keeping
aircraft attitudes indicator displays		capability
(AD-768345) N74	I-14126	[AD-768673] N74-14770 BALLOTES
Dynamics of slung bodies utilizing a rotating		Performance of a ballute decelerator towed behind
wheel for stability	_40484	a jet airplane
AUTOMATIC CONTROL	-18141	[NASA-TH-X-56019] N74-14760 BERDING VIBRATION
Automatic control aspects of a control-configue aircraft with allowance for maneuver load co	red	Nonstationary vibrations of a rigidly supported
	9ntro1 ∤-17216	flexible rotor of variable mass A74-17851
AUTOMATIC FLIGHT CONTROL		BLADE TIPS
Automatic balancing of an aircraft A74	ı-1780 4	Isolated airfoil - TIP vortex interaction noise [AIAA PAPER 74-194] A74-18831
Flight control computerized aircraft quida	ance	BLOWING
A74 Automatic flight controls in fixed wing aircra	!-18181 :ff -	Influence of boundary layer blowing on the low-speed aerodynamic performance of a 45 degree
The first 100 years		swept-wing airplane
A self-reorganizing digital flight control sys	4-18296 stem	[AIAA PAPER 74-269] A74-18674 Some specific characteristics of small gas
for aircraft		turbines and the modeling problems of their wind
[AIAA PAPER 74-21] A74 Automatic Flight Control System development fo	I-18808	tunnel testing
U.S. Army heavy lift helicopter		BLUNT BODIES . A74-18682
[AIAA PAPER 74-25] A74 Electronic displays and digital automatic cont	-18865 	Supersonic flow past sharp- and blunt-mosed
in advanced terminal area operations		conical bodies at angles of attack from 0 to 45 deg
[AIAA PAPER 74-27] A74- AUTOMATIC LANDING CONTROL	-18881	[DGLR PAPER 73-080] . A74-17186
Multi-input, multi-output regulator design for	:	Calculation of the boundary-layer flow in the windward symmetry plane of a spherically blunted
constant disturbances and non-zero set point with application to automatic landing in a	s	axisymmetric body at angle of attack, including
crosswind		stream line-swallowing effects [AD-768340] W74-13992
[NASA-CR-136618] N74-	-15378	Drag in hypersonic rarefied flow effects of
Automatic control of a helicopter with a hangi	.ng	cold pressure drag and friction drag
load development and evaluation of autom- pilot for use with S-61 belicopter	atic	BODIES OF REVOLUTION
[NASA-CR-136504] N74	I-13715	Calculation of potential flow about axially symmetric fuselages, annular profiles and engine
AUXILIARY POWER SOURCES Some specific characteristics of small gas		inlets
turbines and the modeling problems of their	wind	[WASA-TT-F-15213] N74-13707 Magnus characteristics of arbitrary rotating bodies
tunnel testing	40700	[AGARD-AG-171] N74-13710
AVIORICS		BODY CENTERED COBIC LATTICES Flat rolled beta titabium alloys for airframe
New concepts in AMTI radar - Nulling effects of Doppler filter/multi-element horn array	£	application
. 17 <i>u</i> .	- 17252	BODY-WING AND TAIL COMPIGURATIONS
Avionics design for maintainability - Are we gaining or losing	-	Wing fuselage structural/concept study for a
[SAE PAPER 730862] A74.	-17531	subsonic transport aircraft [SAE PAPER 730886] A74-17533
Theory and practice of avionics reliability		BODY-WING CONFIGURATIONS
The 5-3A - A new dimension in airborne sea con-	-18597 trol	Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] A74-18812
	-19205	(====

BORING 747 AIRCRAFT		CARGO AIRCRAPT	ent for
The new Advanced Airborne Command Post		Automatic Plight Control System developm U.S. Army heavy lift helicopter	
[AIAA PAPER 74-240]	A74-18654	[AIAA PAPER 74-25]	A74-18865
BORBER AIRCRAFT	walustion		do of
Exhaust system interaction program e of exhaust system installation losses	and effect	Characteristics of the wake behind a cas	cade of
on aircraft performance		airfoils	174-17495
[AD-769086]	¥74-14747	Theoretical investigation of supersonic	flow past
BOWNING MARTDHEUR	1 starce	oscillating cascades with subsonic lea	ding-edge
A pylon to decrease the effects of exter	Hal Stores	locus	A74-18843
on the stability of aircraft	N74-13749	(AIAA PAPER 74-14)	W14-10047
(AD-767913] BOUNDARY LAYER CONTROL		CASTING Evolution of applications of precision of	asting in
T-fluores of boundary layer blowing on t	the	turbojets	
low-speed aerodynamic periormance or a	1 42 dedies	•	A74-17892
swept-wing airplane	A74-18674	CATALYTIC ACTIVITY	
[AIAA PAPER 74-269] BOUDDARY LAYER FLOW		The refining of turbine fuels by modern	
Ablation heat and mass transfer in h	hypersonic	hydrotreating [AIAA PAPER 74-162]	A74-18798
flight	A74-17103	CHEMPTHICET COMPRESORS	_
Artificial development of an atmospheric		maaling a high processor Tatlo Centilius	qal
lance flow model in a wind funnel	CRITIC BING	compressor using a low speed of sound	774-14444
flow modulating devices at wind tunner	I SUCTABLE	[AD-767241]	
	N/4-13/01	CERTIFICATION New jumbo jets must speak in whispers -	Certifying
Calculation of the boundary-layer flow	in the	the Lockheed 1011	
vindward symmetry plane of a spherica axisymmetric body at angle of attack,	including		A74-17856
stream line-swallowing effects	,	CESSEA AIRCRAFT Flight test data for a Cessna Cardinal	steady
r m 7603603	พ74-13992	state performance and fixed stick dynamics	amic
Plutter computer program and lifting su	rface	stability characteristics	
theory with boundary layer	¥74-14707	[NASA-CR-2337]	N74-14752
[NASA-CH-136559] BOUNDARY LAYER SEPARATION		CH-47 BELICOPTER	CH-47
similar parameters and their sensiti	wity for	Recommended design modifications to the forward rotor drive gearbox	Cit 47
transonic airframe exhaust nozzle int	eractions N74-14746	cap-7690621	N74-14775
[AD-768988]	M/4- (4/40	nationaring appraisal of Southwest Rese	arch
Evaluation of the influence of errors in	n.	Institute magnetic crack definer appl	ied to CH4/
twing boundary conditions on the	! accuracy	rotor blades	N74-14778
of the determination of temperature I	ields in	[AD-769068] CHARACTERISTICS	-
infinite cylinders	A74-18635	Drag and separation effects of sepa	rated flow
	1,4 ,000-	on aerodynamic drag	N74-14722
NAU BITPC		•	
BOW WAVES A relaxation method for calculating tra	nsonic	CULCATO	
BOW WAYES A relaxation method for calculating tra flows with detached bow shocks		CULCATO	
A relaxation method for calculating tra flows with detached bow shocks	nsonic A74-16970		n vehicles
a relaxation method for calculating tra flows with detached bow shocks	A74-16970	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172]	
a relaxation method for calculating tra flows with detached bow shocks BRAKING Recent studies of tire braking performs	A74-16970	CHASSIS Restraint procedures for cargo loaded i to be air transported [10-768172]	n vehicles N74-13954
A relaxation method for calculating tra flows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft	A74-16970	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Labeleris and calculation of lightning-i	n vehicles N74-13954 nduced
a relaxation method for calculating tra flows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft	A74-16970 Ance for A74-17898	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu	n vehicles N74-13954
a relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS)	174-16970 ance for 174-17898 tics of a	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349]	N74-13954 nduced nits
a relaxation method for calculating tra flows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft	174-16970 ance for 174-17898 tics of a	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATION Now technologies and profitability of h	n vehicles N74-13954 Induced Lits N74-1475
a relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATIOS New technologies and profitability of h application of helicopters to com-	n vehicles N74-13954 Induced Lits N74-1475
a relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to con operations [NASA-TT-F-15195]	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Emercial N74-1371
a relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TT-F-15195] Whisting needs and public concerns	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Induced N74-1371
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING BUCKLING Curved ribbed aluminum weight of co-	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Induced N74-1371
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRACHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control	n vehicles N74-13954 induced iits N74-1475 ielicopters mercial N74-1371 civil mental N74-1474
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUPFETING An experimental analysis and buffet into the shockless lifting airfoil no.	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control	n vehicles N74-13954 induced iits N74-1475 ielicopters mercial N74-1371 civil mental N74-1474
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRACHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Induced N74-1371 Civil Induced N74-1474
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING Buckling loads and minimum weight of co- curved ribbed aluminum alloy panels BUPFETING An experimental analysis and buffet in- of the shockless lifting airfoil no. [NRC-13673]	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATIOB New technologies and profitability of h application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control Porty years of civil aviation, 1931 Italy	n vehicles N74-13954 induced iits N74-1475 ielicopters mercial N74-1371 civil mental N74-1474
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUPFETING An experimental analysis and buffet into the shockless lifting airfoil no.	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation	CHASSIS Restraint procedures for cargo loaded in to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-involtages in aircraft electrical circular [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of the application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns—aviation growth in Europe and environ control Porty years of civil aviation, 1931—Italy	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Indercial N74-1371 Civil Inmental N74-1474 1971 for N74-1475
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRABCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of co- curved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673]	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708	CHASSIS Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of here application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Mercial N74-1371 Civil Mental N74-1474 1971 for N74-1475 Casting in
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performa- aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of co- curved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in- of the shockless lifting airfoil no. [NRC-13673] C CAMBBERED WINGS Unsteady lift forces on highly cambere	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708	CHASSIS Restraint procedures for cargo loaded in to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-involtages in aircraft electrical circular [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of the application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns—aviation growth in Europe and environ control Porty years of civil aviation, 1931—Italy	n vehicles N74-13954 Induced Lits N74-1475 Relicopters Indercial N74-1371 Civil Inmental N74-1474 1971 for N74-1475
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRABCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING Buckling loads and minimum weight of co- curved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in- of the shockless lifting airfoil no. [NRC-13673] C CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708	Restraint procedures for cargo loaded in to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-involtages in aircraft electrical circum [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of header application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns	n vehicles N74-13954 Induced iits N74-1475 Relicopters mercial N74-1371 civil mental N74-1474 1971 for N74-1475 casting in
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of co- curved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673] CAMBRERD WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88]	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns aviation qrowth in Europe and environ control Porty years of civil aviation, 1931 Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS	n vehicles N74-13954 Induced iits N74-1475 Relicopters mercial N74-1371 civil mental N74-1474 1971 for N74-1475 casting in A74-1789 ockpit, or
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRABCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING Buckling loads and minimum weight of co- curved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in- of the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CAMBED COMPIGURATIONS Trimmed drag and maximum flight effici	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns space system functions transfer	n vehicles N74-13954 Induced lits N74-1475 Relicopters Induced Intercial N74-1371 Civil Inmental N74-1474 INTERCIAL N74-1475 Casting in A74-1789 Ockpit, or
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673] C CAMBBERD WINGS Unsteady lift forces on highly cambere moving through a gust [ATAA PAPER 74-88] CAMARD COMPTIGURATIONS Trimmed drag and maximum flight efficit tail and canard configurations	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807	Restraint procedures for cargo loaded in to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-involtages in aircraft electrical circum [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of header application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns	n vehicles N74-13954 Induced iits N74-1475 Relicopters mercial N74-1371 civil mental N74-1474 1971 for N74-1475 casting in A74-1789 ockpit, or
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRACHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet intof the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CAMAND COMPIGURATIONS Trimmed drag and maximum flight efficit tail and canard configurations [AIAA PAPER 74-69] Central Configured Vehicle Ride Control	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TT-F-15195] Aviation needs and public concerns aviation qrowth in Europe and environ control Porty years of civil aviation, 1931 - I Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, co space system functions transfer or satellites [AIAA PAPER 74-262]	n vehicles N74-13954 Induced Induced
A relaxation method for calculating tra- flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673] C CAMBBERD WINGS Unsteady lift forces on highly cambere moving through a gust [ATAA PAPER 74-88] CAMARD COMPTIGURATIONS Trimmed drag and maximum flight efficit tail and canard configurations	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns aviation qrowth in Europe and environ control Porty years of civil aviation, 1931 Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, c space system functions transfer or satellites [AIAA PAPER 74-262] COLD WORKING Development of cold headable titanium	n vehicles N74-13954 Induced Induced
A relaxation method for calculating tra flows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRACCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUPFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673] C CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CANARD CONFIGURATIONS Trimmed drag and maximum flight efficit tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Contro B-52 control system analysis, synthe design	A74-16970 Ance for A74-17898 tics of a E branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813 1 (CCV RCS). sis, and	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TT-F-15195] Aviation needs and public concerns aviation qrowth in Europe and environ control Porty years of civil aviation, 1931 - I Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, co space system functions transfer or satellites [AIAA PAPER 74-262]	n vehicles N74-13954 Induced Induced
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of Courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CANARD COMPTIGURATIONS Trimmed drag and maximum flight efficitial and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthe design [AD-767590]	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS halysis and calculation of lightning-i voltages in aircraft electrical circu [NASA-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASA-TT-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control Porty years of civil aviation, 1931 Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, compace system functions transfer or satellites [AIAA PAPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet	n vehicles N74-13954 Induced iits N74-1475 Relicopters mercial N74-1371 civil mental N74-1474 1971 for N74-1475 casting in A74-1789 ockpit, or to aircraft A74-1866 alloys for
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet into the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CHMAND COMPIGURATIONS Trimmed drag and maximum flight efficitial and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthe design [AD-767590] CARBOB FIBRES	174-16970 174-17898 11cs of a 15 branch modes 174-18291 1 ompressed 174-16822 1 vestigation 1 N74-14708 1 d airfoils 1 A74-18807 1 ency of aft 174-18813 1 (CCV RCS) 1 sis, and 174-13728 1 lents - side	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns space system functions transfer or satellites [AIAA PAPPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet	n vehicles N74-13954 Induced iits N74-1475 Relicopters mercial N74-1371 civil mental N74-1474 1971 for N74-1475 casting in A74-1789 ockpit, or to aircraft A74-1866 alloys for
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet into the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CHMAND COMPTIGURATIONS Trimmed drag and maximum flight efficitial and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthe design [AD-767590] CARBOB FIBRES Graphite composite landing gear compondate assembly and torque link for A	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813 compressed A74-18813 compressed A74-18813 d (CCV RCS). sis, and A74-13728 tents - side A7 B aircraft	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation growth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns space system functions transfer or satellites [AIAA PAPPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet COLOR PHOTOGRAPHY A color schlieren system	n vehicles N74-13954 Induced iits N74-1475 Relicopters mercial N74-1371 civil mental N74-1474 1971 for N74-1475 casting in A74-1789 ockpit, or to aircraft A74-1866 alloys for
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performs aircraft BRACHING (MATHEMATICS) Calculation of the dynamic characterist helicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet into the shockless lifting airfoil no. [NRC-13673] C CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CANARD COMPIGURATIONS Trimmed drag and maximum flight efficitatil and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthe design [AD-767590] CARBON FIBRES Graphite composite landing gear compondation assembly and torque link for A [AD-769041]	174-16970 174-17898 11cs of a 15 branch modes 174-18291 1 ompressed 174-16822 1 vestigation 1 N74-14708 1 d airfoils 1 A74-18807 1 ency of aft 174-18813 1 (CCV RCS) 1 sis, and 174-13728 1 lents - side	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation qrowth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns space system functions transfer or satellites [AIAA PAPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet COLOR PHOTOGRAPHY A color schlieren system COMBINED STRESS	n vehicles N74-13954 Induced Inits N74-1475 Indicopters Interior Interior N74-1371 Interior N74-1474 1971 for N74-1475 Casting in A74-1789 Interior A74-1866 Interior A74-1655 Interior A74-1780
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft BRACHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet in of the shockless lifting airfoil no. [NRC-13673] CAMBBERD WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CANARD COMPIGURATIONS Trimmed drag and maximum flight efficital and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthe design [AD-767590] CANDON FIBERS Graphite composite landing gear compon brace assembly and torque link for A [AD-769041] CARBE WINGS	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813 compressed A74-18813 compressed A74-18807 ency of aft A74-1879 wings over	Restraint procedures for cargo loaded in to be air transported [AD-768172] CINCUITS Analysis and calculation of lightning-involtages in aircraft electrical circumants [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of header application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concernstiation quowth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns atellites [AIAA PAPPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet COLOR PHOTOGRAPHY A color schlieren system COMBINED STRESS An algorithm for rational selection of parameters of nonlinearly deforming	n vehicles N74-13954 Induced Inits N74-1475 Indicopters Interior Interior N74-1371 Interior N74-1474 1971 for N74-1475 Casting in A74-1789 Interior A74-1866 Interior A74-1655 Interior A74-1780
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft BRABCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of belicopter structure by the method of curved ribbed aluminum alloy panels BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet into the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CAMBED CONFIGURATIONS Trimmed drag and maximum flight efficitial and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthed design [AD-767590] CARBON FIBERS Graphite composite landing gear componing the composite composite landing gear componing trace assembly and torque link for a [AD-769041] CART WINGS Porce measurements on caret and delta	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813 ccv RCS). sis, and N74-13728 tents - side A37 B aircraft N74-1779 wings over	Restraint procedures for cargo loaded i to be air transported [AD-768172] CIRCUITS Analysis and calculation of lightning-i voltages in aircraft electrical circu [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of h application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concerns aviation qrowth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns space system functions transfer or satellites [AIAA PAPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet COLOR PHOTOGRAPHY A color schlieren system COMBINED STRESS	n vehicles N74-13954 Induced lits N74-1475 Relicopters Induced Interval
A relaxation method for calculating traflows with detached bow shocks BRAKING Recent studies of tire braking performa aircraft BRANCHING (MATHEMATICS) Calculation of the dynamic characterist belicopter structure by the method of BUCKLING Buckling loads and minimum weight of courved ribbed aluminum alloy panels BUFFETING An experimental analysis and buffet into the shockless lifting airfoil no. [NRC-13673] CAMBERED WINGS Unsteady lift forces on highly cambere moving through a gust [AIAA PAPER 74-88] CHMED COMPIGURATIONS Trimmed drag and maximum flight efficitial and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control B-52 control system analysis, synthe design [AD-767590] CABBOB FIBRES Graphite composite landing gear compon brace assembly and torque link for A. [AD-768941]	A74-16970 Ance for A74-17898 tics of a f branch modes A74-18291 compressed A74-16822 vestigation 1 N74-14708 d airfoils A74-18807 ency of aft A74-18813 ccv RCS). sis, and N74-13728 tents - side A37 B aircraft N74-1779 wings over	Restraint procedures for cargo loaded in to be air transported [AD-768172] CINCUITS Analysis and calculation of lightning-involtages in aircraft electrical circumants [NASI-CR-2349] CIVIL AVIATION New technologies and profitability of header application of helicopters to comperations [NASI-TI-F-15195] Aviation needs and public concernstiation quowth in Europe and environ control Porty years of civil aviation, 1931 - Italy COBALT ALLOYS Evolution of applications of precision turbojets COCKPITS Future air traffic control - Ground, concerns atellites [AIAA PAPPER 74-262] COLD WORKING Development of cold headable titanium the 'Concorde' supersonic jet COLOR PHOTOGRAPHY A color schlieren system COMBINED STRESS An algorithm for rational selection of parameters of nonlinearly deforming	n vehicles N74-13954 Induced Inits N74-1475 Indicopters Interior Interior N74-1371 Interior N74-1474 1971 for N74-1475 Casting in A74-1789 Interior A74-1866 Interior A74-1655 Interior A74-1780

COMBUSTION CHARBERS

SUBJECT INDEX

COMBUSTION CHAMBERS	COMPRESSIBLE FLOW
Estimation and optimization of the film cooling	Development of a method of
requirements in a qas turbine combustion chamber [CRAMPIELD=SME-5] N7a-14439	discretized-distribution singularities for the
A proposed method for calculating film-cooled wall	study of compressible and incompressible flows
CRANFIELD-SME-41	A color schlieren system
The divided combustion chamber concept and decise	Thron-dimensional
for control of SI engine exhaust air pollutant emissions	Three-dimensional compressible boundary layer flow over a yawed cone with mass injection
COMBUSTION EFFICIENCY N74-15454	COMPRESSION LOADS N74-13960
The hydrogen fuel economy and aircraft propulsion	Buckling loads and minimum weight of compressed curved ribbed aluminum alloy panels
COMBUSTION PHYSICS	174_46630
Parameters controlling nitric oxide emissions from qas turbine combustors	Analytical design of optimal monolithic panels A74-18642
N7#=4h204	COMPRESSOR BLADES Theoretical investigation of supersonic flow past
COMBUSTION PRODUCTS Indestion and dispersion of engine exhaust	oscillating cascades with subsonic leading-edge
products by trailing vortices for supersonic	LOCUS
rilgat in the stratosphere	[AIAA PAPER 74-14] A74-18843 COMPUTER GRAPHICS
[AIAA PAPER 74-42] A74-18815	Plotting program for aerodynamic lifting surface
Atmospheric Pollution by Aircraft Engines [AGARD-CP-125]	theory user manual for FORTRAN computer
Parameters controlling nitric oxide emissions from	program
qas turbine combustors	[NASA-TH-X-62321] N74-14739 COMPUTER PROGRAMMING
M74-14291	Evaluation of the operations contained in
Technical evaluation report on AGARD Technical	algorithms carried out by digital controller
Recting on Atmospheric Pollution by Aircraft Engines requirement to analyze contribution	computers
o dir politicion near alreorts from various	A74-18638
Sources	A computer program for aircraft optimal control problems
[AGABD-AR-63] H74-15349	[AD -7670+03
COMBUSTION STABILITY Combustion generated noise in turbopropulsion	Flutter computer program and lifting surface
systems	theory with boundary layer
[AD-768615] B74-15666	[NASA-CR-136559] N74-14707
	Structural analysis of light aircraft using NASTRAN
The new Advanced Airborne Command Post [AIAA PAPER 78-240]	
Airborne Warning and control sector /huace/	APP41Cation of an improved unified
tor air operations management during military	subsonic-supersonic potential flow method for
CIISES	the aerodynamic analysis of aircraft configurations
[AIAA PAPER 74-241] A74-18655 COMMBRCIAL AIRCRAFT	· [AIAA PAPER 74-186]
The aftermath of a bijacking - Passenger claims	A real-time digital program for actimating
and insurance	aircraft stability and control parameters from
Hew technologies and the last	flight test data by using the maximum likelihood method
Hew technologies and profitability of helicopters application of helicopters to commercial	(WASA-TH-X-2788) N74-13882
chargeious	Structural analysis of light aircraft using NASTRAN
f NASA-TT-P-151951 N74-13717	771_41ED4
COMPOSITE MATERIALS	Blade dynamics analysis using NASTRAN effects of blade geometry, temperature gradients, and
Titanium - The bridge to composites for light weight/high performance aircraft	rotational speed
174-46484	84044 and 3-4 14599
application of advances in structures and materials to the design of the YP-17 simple-	Static and dynamic helicopter airframe analysis with NASTRAN
1045 FAFER /3U8911 190 49505	NASTRAN data generation of helicopter fuselages
Study of structural criteria for composite airframes, Volume 1: Evaluation	using interactive graphics propresses-
IAD=7677061	system for fibité element analysis neing TRM
Study of structural criteria for composite	Computer
MANAGECO: [Oliume /: Correst /coileant / - 1 - 1 - 1	Plotting program for aerodynamic lifting surface
Canada review and evaluation	theory user manual for FORTRAN computer
Analytical and experimental investigation in	program
GALCAGA METAL STRUCTURES FOINFARGA LILL	[NASA-TH-X-62321] N74-14739
"III dentary composites, Phase 3: Mador	COMPUTER TRCHNIQUES
component development [NASA-CR-2122]	Computer prediction of aircraft noise
Graphite composite landing gear components - side	COMPUTERIZED DESIGN A74-19051
brace assembly and torque link for A37 R sircraft	The use of fully stressed iteration and structural
1 50-703047 1170-46376	Index in automated structural optimization
CUBPUSITE STRUCTURES	A74-17739 Analytical design of optimal monolithic panels
A sailplane wing constructed of foam core and polyester fiberglass skin	170 - 40cha
[AIAA PAPER 74=2581	Determination of the basic parameters of light
Development of a graphite bonigants	mericopiess on the basis of the treatment
	analysis of statistical data
[AD-768869]	Computer program to perform cost and weight
COMPRESSIBILITY RPPROTE	andlysis of transport different. Volume 1.
Effect of compressibility on them district.	Fully CD-122244
neilcopter rotor blade flutter	Computer program to perform cost and washing
N74-13714	auguysis of transport aircraft. Volume 2.
	TACTUTEST AOTOBS
	[MASA-CR-132362] W70-10763

SUBJECT INDEX

Application of the aerospace multiprocessor A-7D flight control system developmen	to the	COST REDUCTION Titanium flamecutting reduces airframe cos	ts A74-16760
Aiαital fly-hy-wire system		************	M14-10700
[AD-768382]	N74-14769 OWEI	COUPLINGS Experimental study of metal-plastic couplitension	ngs in
required for single and tandem rotor heli in hover and forward flight	COPUSTO	ANAR MODICISTOR	A74-18648
[AD-768769]	N74-14777	Fracture mechanics /Dryden Lecture/ ae	rospace
COMPOTERIZED SINGLATION Structural analysis of light aircraft using	HASTRAN	structural design applications [AIAA PAPER 74-230]	A74-18858
[AIAA PAPER 74-257] Evaluation of aircraft departure divergence	A /4- 10004	- " opposion of Southwest Researc	h +0 CH47
criteria with a six-degree-of-freedom alo	ital	Institute magnetic crack definer applied rotor blades	
simulation program [ATAA PAPER 74-68]	A74-18682	[AD-769068]	N74-14778
COMCORNE ATRCDAPE	For	CRACKING (FRACTORING) Pailure experience with and failure antici	pation
Development of cold headable titanium allow the 'Concorde' supersonic jet		in titanium components	A74-16476
Stratosphere contamination by aircraft and	A74-16554	CRASH LANDING	ivad
mathematical models	A74-17312	Yehicle crashworthiness rotary wing, f wing light and transport aircraft	
herodynamic aspects of the problems of air	-intakes		A74-17776
	LLCLAIL	CREEP STREEGTH Dynamic creep of titanium alloy with 1.5 w	t % An
design of air intake and after body of engine for Concorde aircraft		and 3% Al in high-velocity air streams	A74-16579
[NAL-TR-194]	p74-14748	CRUISING PLIGHT	
COMPERENCES Atmospheric Pollution by Aircraft Engines		On the fuel optimality of cruise for a	11CCTA11 A74-18142
[AGARD-CP-125]	N74-14271	CURVED PARELS	-
Aerodynamic Drag [AGARD-CP-124]	N74-14709	Buckling loads and minimum weight of compt curved ribbed aluminum alloy panels	essed
CONSTRUCTION MATERIALS Materials for the new generation of aircra	ft	Cataed Cibbed Gigarage grie, harring	A74-16822
	#14- 11314	CYCLIC LOADS High cycle fatique properties of titanium	in
Section 3: Stability, construction materi construction methods	als,	aircraft application	A74-16513
Constituent mermons	N74-14670	CYLINDRICAL BODIES	
CONTAINERS Refrigerated containerized transport for	Jumbo*	a maked of calculating the flow around a	wing of indrical
jets	A74-17007	arbitrary planform, positioned on a cyl- body	
CONTROL EQUIPMENT		Evaluation of the influence of errors in	A74-18632
Turbojet aircraft engine test cell polluti	OL	appoint in a houndary conditions on the a	ccuracy
abatement study	N74-13957	of the determination of temperature file	lds in
abatement study [AD-768287]	N74-13957	of the determination of temperature fie infinite cylinders	1ds in 174-18635
abatement study [AD-768287] CONTROL SUMPACES Multi-surface system for the CCV B-52 Configured Vehicles	N74-13957 Control	of the determination of temperature fie infinite cylinders	1QS 10
abatement study [AD-768287] CONTROL SURFACES Multi-surface system for the CCV B-52 Configured Vehicles [Add Dept. 74-2061]	N74-13957 Control N74-18851	of the determination of temperature fie infinite cylinders	1QS 10
abatement study [AD-768287] CONTROL SURPACES Multi-surface system for the CCV B-52 Configured Vehicles [AIMA PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium	N74-13957 Control A74-18851 Lume 2:	of the determination of temperature fie infinite cylinders D DAMPING TESTS Traffight stabilization of externally slu	A74-18635
abatement study [AD-768287] CONTROL SURPACES Multi-surface system for the CCV B-52 Configured Vehicles [AIMA PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561]	N74-13957 Control A74-18051 Lume 2: N74-13733	of the determination of temperature fie infinite cylinders D DAMPING TESTS In-flight stabilization of externally slubelization of external of exter	145 10 A74-18635 nq t, and
ahatement study [AD-768287] CONTROL SURFACES Multi-surface system for the CCV B-52 Configured Vehicles [ATAN PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] CORROSION PREVENTION	N74-13957 Control A74-18851 Lume 2: N74-13733	of the determination of temperature fie infinite cylinders D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys	145 10 A74-18635 nq t, and
abatement study [AD-768287] CONTROL SURPACES Multi-surface system for the CCV B-52 Configured Vehicles [AIMA PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561]	N74-13957 Control A74-18851 Lume 2: N74-13733	of the determination of temperature fie infinite cylinders D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys [AD-769063]	105 10 174-18635 nd t, and tens 174-14774
ahatement study [AD-768287] CONTROL SURFACES Multi-surface system for the CCV B-52 Configured Vehicles [ATAN PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] CORROSION PREVENTION Evaluation of methods for reducing frettit fatique damage in 2024-T3 aluminum lap	N74-13957 Control A74-18851 Lume 2: N74-13733 Indicates A74-16696	of the determination of temperature fie infinite cylinders D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys [AD-769063] DATA ACQUISITION Data acquisition, processing, and control advanced aircraft	108 10 174-18635 nq t, and tees N74-14774
abatement study [AD-768287] CONTROL SURFACES Multi-surface system for the CCV B-52 Configured Vehicles [ATAN PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] COBROSION PERVENTION Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap COST AMALYSIS	N74-13957 Control A74-18851 Lume 2: N74-13733 A74 Joints A74-16696	of the determination of temperature fie infinite cylinders D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys [AD-769063] DATA ACQUISITION Data acquisition, processing, and control advanced aircraft	108 10 174-18635 nd t, and teens 174-14774 for 174-17542
ahatement study [AD-768287] CONTROL SURFACES Multi-surface system for the CCV B-52 Configured Vehicles [ATAA PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] CORROSION PREVENTION Evaluation of methods for reducing frettil fatique damage in 2024-T3 aluminum lap COST AMALYSIS Comparative study of various flight vehic propulsion systems, using an air-to-air as an example	N74-13957 Control A74-18851 Lume 2: N74-13733 A74 Joints A74-16696	of the determination of temperature fie infinite cylinders D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys [AD-769063] DATA ACQUISITION Data acquisition, processing, and control advanced aircraft	108 10 174-18635 nq t, and tees N74-14774 for 174-17542 insulated
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ahatement study [AD-768287] CONTROL SURPLES Multi-surface system for the CCV B-52 Configured Vehicles [ATAA PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] CORROSION PREVENTION Evaluation of methods for reducing frettir fatique damage in 2024-T3 aluminum lap COST AHALYSIS Comparative study of various flight vehic propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] An approach toward optimizing material co- part function in advanced powerplants [SAE PAPER 730909] Importance of the means of engine conditi- surveillance Economics of air transport direct and costs [NASA-TT-F-15249] Computer program to perform cost and weig analysis of transport aircraft. Volume Summary [NASA-CB-132361] COST EFFECTIVENERSS B-1 cost/weight trade methodology Military and aerospace cost effective technology utilization for ATC, NASA pr and defense projects New technologies and profitability of hel application of helicopters to comme operations	N74-13957 Control A74-18851 Lume 2: N74-13733 A74-16696 A74-16696 A74-17177 st and A74-17535 On A74-18598 indirect N74-14682 A74-14682	D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys [AD-769063] DATA ACQUISITION Data acquisition, processing, and control advanced aircraft [SAE PAPER 730957] Dynamic test of air data computers with s flight profiles Appendix: A data item service for aircra estimation collection, dissemination development of aerodynamic drag predict A quick look at the state-of-the-art in t testing of certain aerodynamic parameter related to wind tunnel testing [FFA-AU-966] DATA CORRELATION Aircraft and systems reliability reliable overhaul and maintenance Three dimensional supersonic flow field of the B-1 airplane by a finite differ- technique and comparison with experime [AIAA PAPER 74-189] A quick look at the state-of-the-art in testing of certain aerodynamic parameter related to wind tunnel testing [FFA-AU-966] DATA MANAGEMENT Problems in data management for earth mo	103 10 A74-18635 nq t, and teens N74-14774 for A74-17542 simulated A74-17736 aft draq on, and cion data N74-14717 fliqht ers N74-14740 ation to A74-18599 analysis ence A74-18877 fliqht ers N74-14740
ahatement study [AD-768287] CONTROL SURPLES Multi-surface system for the CCV B-52 Configured Vehicles [ATAM PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] CORROSION PREVENTION Evaluation of methods for reducing frettif fatique damage in 2024-T3 aluminum lap COST AHALYSIS Comparative study of various flight vehic propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] An approach toward optimizing material co- part function in advanced powerplants [SAE PAPER 730909] Importance of the means of engine conditi- surveillance Economics of air transport direct and costs [NASA-TT-F-15249] Computer program to perform cost and weig analysis of transport aircraft. Volume Summary [NASA-CB-132361] COST EFFECTIVENESS B-1 cost/weight trade methodology Military and aerospace cost effective technology utilization for ATC, NASA pr and defense projects New technologies and profitability of hel application of helicopters to comme operations [NASA-TT-F-15195]	N74-13957 Control A74-18851 Lume 2: N74-13733 A74-16696 Le Bissile A74-17177 st and A74-17535 on A74-18598 indirect N74-14682 bt 1: N74-14762 A74-16447 ograms A74-18050 icopters ircial N74-13717	D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys [AD-769063] DATA ACQUISITION Data acquisition, processing, and control advanced aircraft [SAE PAPER 730957] Dynamic test of air data computers with s flight profiles Appendix: A data item service for aircra estimation collection, disseminatic development of aerodynamic drag predict A quick look at the state-of-the-art in testing of certain aerodynamic parameter related to wind tunnel testing [FFA-AU-966] DATA CORBELATION Aircraft and systems reliability reliable overhaul and maintenance Three dimensional supersonic flow field of the B-1 airplane by a finite differ- technique and comparison with experime [ATAM PAPER 74-189] A quick look at the state-of-the-art in testing of certain aerodynamic parameter related to wind tunnel testing [FFA-AU-966]	103 10 A74-18635 nq t, and teens N74-14774 for A74-17542 simulated A74-17736 aft draq on, and cion data N74-14717 fliqht ers N74-14740 ation to A74-18599 analysis ence A74-18877 fliqht ers N74-14740
ahatement study [AD-768287] CONTROL SURPLES Multi-surface system for the CCV B-52 Configured Vehicles [ATAA PAPER 74-126] STOL tactical aircraft investigation. Vol Design compendium [AD-767561] CORROSION PREVENTION Evaluation of methods for reducing frettir fatique damage in 2024-T3 aluminum lap COST AHALYSIS Comparative study of various flight vehic propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] An approach toward optimizing material co- part function in advanced powerplants [SAE PAPER 730909] Importance of the means of engine conditi- surveillance Economics of air transport direct and costs [NASA-TT-F-15249] Computer program to perform cost and weig analysis of transport aircraft. Volume Summary [NASA-CB-132361] COST EFFECTIVENERSS B-1 cost/weight trade methodology Military and aerospace cost effective technology utilization for ATC, NASA pr and defense projects New technologies and profitability of hel application of helicopters to comme operations	N74-13957 Control A74-18851 Lume 2: N74-13733 A74-16696 Le Bissile A74-17177 st and A74-17535 on A74-18598 indirect N74-14682 bt 1: N74-14762 A74-16447 ograms A74-18050 icopters ircial N74-13717	D DAMPING TESTS In-flight stabilization of externally slu helicopter loads design, developmen evaluation of candidate stabilizing sys {aD-769063} DATA ACQUISITION Data acquisition, processing, and control advanced aircraft [SAE PAPER 730957] Dynamic test of air data computers with s flight profiles Appendix: A data item service for aircraft extination collection, dissemination development of aerodynamic drag predict A quick look at the state-of-the-art in testing of certain aerodynamic parameter related to wind tunnel testing [FFA-NU-966] DATA CORRELATION Aircraft and systems reliability related to wind tunnel testing overhaul and maintenance Three dimensional supersonic flow field of the B-1 airplane by a finite differtechnique and comparison with experime (ATAM PAPER 74-189) A quick look at the state-of-the-art in testing of certain aerodynamic parameter related to wind tunnel testing (FFA-AU-966) DATA MANAGEMENT Problems in data management for earth momensions	and tems N74-14774 for A74-1774 for A74-17736 aft draq m, and tion data N74-14717 light ers N74-14740 ation to A74-18599 annle and A74-18877 flight ers N74-14740 nitoring

DATA PROCESSING	DISTANCE MEASURING EQUIPMENT
Data acquisition, processing, and control for advanced aircraft	Microvave Landing System (MLS) development plan ac
[SAB PAPER 7309571	Proposed by Raytheon during the techniqui
DECOUPLING	analysis and contract definition phase of the national MLS development program, Volume 3A
Decoupling of a class of nonlinear systems and its	[FAA-RD-73-150-3A] H74-15383
application to an aircraft control problem	DISTILLATION
DEFENSE PROGRAM	
Military and aerospace cost effective	thermal cracking of crude oil residues
technology utilization for ATC. NASA programs	DOPPLER RADAR A74-18925
and defense projects	New concepts in AMTI radar - Walling offcate of
A74-1805 Airborne warning and control system /AWACS/	Doppler filter/multi-element horn array
for air operations management during military	DOWNWASH A74-17252
CIlses	Improvement of the downflow conditions below a
[AIAA PAPER 74-241] A74-1865: DEGREES OF PREEDOM	integrated shrouded propeller
Evaluation of aircraft departure divergence	174-17901
criteria with a six-degree-of-freedom digital	DRIG DEVICES Performance of a ballute decelerator towed behind
Simulation program	a let airplane
[AIAA PAPER 74-68] A74-1888:	2 [BASA-TH-X-56019] p7h-10760
A wortex entrainment model applied to slender	NAWA BEFOREDERL
delta wings	In experimental analysis and buffet investigation of the shockless lifting airfoil no. 1
Humarical importing the second	7 NEC-136731 171 46760
Numerical investigation of vortex sheets issuing from a separation line near the leading edge	A Survey of drag prediction techniques applicable
170. 10200	to Supsonic and transonic atropatt decima
roice measurements on caret and delta wings over	On some basic and new aspects about the drag
the incidence range 27 deg less than on count to	problem of wings and bodies in supersonic flows
alpha less than or equal to 55 deg at # 12.2	ロウルー 4カフィン
Drag of lifting bodies for pilots at high altitude	neasurements of the drag of some characteristic
¥76_ ##334	aircraft excrescences immersed in turbulent boundary layers
Analysis of the flow about delta wings with leading edge separation at supersonic speeds	1770-110711
NASA-UK-132358 N7a-10705	Problems of estimating the drag of a beliconter
DIGITAL COMPOTERS	correlation of flight test data and scale model test data
Evaluation of the operations contained in	107 h _ 4 h 7 a c
algorithms carried out by digital controller computers	AlfCraft drag prediction for project appraisal and
170 ancon	performance estimation
Diectropic displays and digital automatic control	Remarks on methods for predicting viscous drag
in advanced terminal area operations [AIRA PAPER 74-27]	derouynamic drag prodiction for high angles of
Evaluation of aircraft departure divorgence	attack and multielement airfoils
Criteria with a Six-degree-of-freedom Aigital	074-14718 Drag of supercritical airfoils in transonic flow
(ATIA DADED 34 COS	COMPACISON With conventional eigenia de-
DIGITAL TECHNIODES	coefficients
A self-reorganizing digital flight control system	N74-14719
first promp of a	Comparison of various methods for calculating profile drag from pressure measurements in the
DIPOLE ANTENHAS	near wake at subcritical speeds
A new ILS localizer for regional airports	976 4575a
37n_40064	Drag and separation effects of separated flow on aerodynamic drag
DISCRETE PURCTIONS Development of a method of	270_40320
discretized-distribution singularities for all	New investigations for reducing the base date of
study of compressible and incompressible flows	Willes with a Diunt trailing odge offers
DISORIBHTATION A74-16968	splitter plates and splitter wedges on aerodynamic drag coefficients
Orientation-error accidents in regular table on a	w74 44-75-3
protect during liscal year 1970: Relative	Meview of drad measurements from flight toots of
incidence and cost	manned aircraft with comparisons to wind-tunnel predictions
An investigation of pattern recognition of	DRAG BEDGGTTOT 874-14735
allCrait attitudes indicator Aignlage	DAMA RADDOTTON
[AD-768345] w7n_40406	Trimmed drag and maximum flight efficiency of aft
DISTRI DEVICES	tail and canard configurations [AIAA PAPER 74-69]
The impact of area navigation on flight control systems and displays	On some basic and new aspects short the and
174 45000	problem of wings and bodies in supersonic flows
Data acquisition, processing, and control for	New investigations for reducing the base drag of
SAR PARPE TONGET	"""" """ " "" " " " " " " " " " " " "
Electronic displays and Aiguel and Aiguel	Sparted Plates and Splitter wedge on
An advanced terminal area operations	aerodynamic drag coefficients
10100 PAPER /4-7/1	The drag of externally carried stores: Its
Tactile display for aircraft control [AD-767763]	Proutction and allegiation Area reduction to
Pield evaluation of ARTS 2 B (MDACAD)	redesign or development of new stropast
proluction of facts beacon for eir traffic	Installetions
[ID=7692031	DROP SIEE H74-14729
H74-14360	Ground contamination by fuel jettisoned from
	aircraft

SUBJECT INDEX ENVIRONMENT POLLUTION

		and the section of th	e and
DROPS (LIQUIDS)		An approach toward optimizing material cospart function in advanced powerplants	
Ground contamination by fuel jettisoned from) m	fear Daper 7309091	<u>874-17535</u>
aircraft	¥74-14283	The T700-GB-700 turboshaft engine program	A74-17536
DYNAMIC CHARACTERISTICS		(SAE PAPER 730917) Heavy Lift Helicopter main engines	A74 17550
columbation of the dynamic characteristics	of a	c - c - c c c c - c - c - c - c - c - c	A74-17537
helicopter structure by the method of bra	A74-18291	The problem of optimal design of qas-turbi	ne engines 174-18083
DYNAMIC CONTROL		The 1et engine design that can drastically	
Decompling of a class of nonlinear systems	and its	oxides of hitrogen	
application to an aircraft control proble	₽# <u>1</u> 74-18139	5	174-18797
DERINIC LOADS		T700 aims at low combat maintenance tu engine for military transports and helic	opters
Static and dynamic helicopter airframe ana	lysis	engine for military transports and the	A74-18998
with NASTRAN	N74-14616	ENGINE PAILURE	_
DYBABIC BODELS		Importance of the means of engine condition	·n
On the fuel optimality of cruise for a	ircraft	surveillance	A74-18598
Helicopter modelling /18th Henson and Stri	E/4-10172	REGISE INLETS	
Lecture/ exploratory, development an	đ	Sonic inlet noise attenuation and performa a J-85 turbofet engine as a noise source	BC6 ATCE
research models		rataa nanun 711-913	A 14-10100
	∆74-18299	namel months decide fabrication, and tes	t of
DYNAMIC RESPONSE Dynamic creep of titanium alloy with 1.5 w	t % Kn	acoustic suppressors for tans of high by	pass
and 3% Al in bigh-velocity air streams		turbofan engines	H74-13724
	<u>174-16579</u>	[NASA-CR-2338] Sonic inlet noise attenuation and performs	ince with
Reduction of wibration and noise generated planetary ring gears in helicopter aircr	py aft	a J-85 torbojet engine as a poise source	1
transmissions	art	CU151-TX-T-718881	N74-14384
[ASHE PAPER 73-PTG-11]	<u> 174-16979</u>	Assessment of the influence of inlet and aftbody/hozzle performance on total airc	craft drag
DERMIC STREETERMS. AWALTSIS	of a		M 14-14 12D
Calculation of the dynamic characteristics helicopter structure by the method of br	anch modes	herodynamic aspects of the problems of air	-intakes
Wellcohter pergentary 21 and and	<u> 274-18291</u>	and enhaust for a supersonic transport and estion of air intake and after body	of let
DINABLE TESTS		engine for Concorde aircraft	
Dynamic test of air data computers with si	Mutated	[NAL-TR-194]	N74-1474B
flight profiles	A74-17736	REGIER HOISE	WASA
		Putting all our noise technology to work . Quiet Engine Program	
E			A74-17049
RCONOBIC FACTORS		Hoise and emission outlook for military e	ngines
			A,
some current problems and prospects for		[ATAA PAPER 73-1156]	st of
Some current problems and prospects for development of rotary-wing aircraft	19681 ·	nevalenmental design fabrication, and te	st of ypass
Some current problems and prospects for development of rotary-wing aircraft	A74-18641	pevelopmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines	ypass
Some current problems and prospects for development of rotary-wing aircraft	-	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines	N74-13724
Some current problems and prospects for development of rotary-wing aircraft BJBCTORS Thin-airfoil theory of an ejector-flapped section	wing	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines (NASA-CR-2338) Noise generation by cylindrical spoilers	N74-13724 immersed power
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187]	-	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines	N74-13724 immersed power e field
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] BLASTIC BODIES Thin-airfoil theory of an ejector-flapped section (AIAA PAPER 74-187)	wing 274-18834	Developmental design, fabrication, and te accustic suppressors for fans of high b turbofan engines [NSSA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [NR-267336]	N74-13724 immersed power
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thiu-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the section of the section of the section of the sections and loss sections and loss sections and loss sections.	wing 174-18834 e ads on	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] [AD-767336]	N74-13724 immersed power e field N74-13730
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] BLASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic with	wing 174-18834 e ads on	Developmental design, fabrication, and te accustic suppressors for fans of high b turbofan engines [NSSA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [NR-267336]	N74-13724 immersed power e field N74-13730 ibition
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure	wing 174-18834 e ads on	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [AD-213637706a]	N74-13724 immersed power e field N74-13730 ibition
Some current problems and prospects for development of rotary-wing aircraft BJBCTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] BLASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locarrent with both rigid and elastic wing attracture [BGLR PAPER 73-078]	wing 174-18834 e ads on ng	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/OGA] Sonic inlet noise attenuation and perform	N74-13724 immersed power e field N74-13730 ibition N74-13752 ance with
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] BLASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic will structure [DGLR PAPER 73-078]	wing A74-18834 e ads on ng A74-17185	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/06A] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source of the second of	N74-13724 immersed power e field N74-13730 ibition N74-13752 ance with e N74-14384
Some current problems and prospects for development of rotary-wing aircraft RJBCTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locarrent with both rigid and elastic wing structure [DGLR PAPER 73-078] BLASTIC SYSTEMS Random wibration with non-linear damping	wing A74-18834 eads on ng A74-17185 A74-18297	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/06A] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise sourc [NASA-TM-I-71488] Research on noise generated by ducted air	N74-13724 immersed power e field N74-13730 ibition N74-13752 ance with e N74-14384
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure [DGLR PAPER 73-078] BLASTIC SISTEMS Random wibration with non-linear damping ELECTRIC EQUIPMENT Applyeis and Calculation of lightning-ind	wing A74-18834 e ads on ng A74-17185 A74-18297	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Wilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/OGA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source [NASA-TH-I-71488] Research on noise generated by ducted air combustion systems	N74-13724 immersed power e field N74-13730 ibition N74-13752 ance with e N74-14384
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure [DGLR PAPER 73-078] BLASTIC SYSTEMS Random wibration with non-linear damping ELECTRIC EQUIPMENT Analysis and calculation of lightning-ind woltages in aircraft electrical circuit	wing A74-18834 e ads on ng A74-17185 A74-18297 uced	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/OGA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source [NASA-TM-I-71488] Research on noise generated by ducted air combustion systems [AD-767337]	N74-13724 immersed power e field N74-13730 ibition N74-13752 image with te N74-14384 -fuel N74-14445
Some current problems and prospects for development of rotary-wing aircraft BJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure [DGLR PAPER 73-078] BLASTIC SYSTEMS Random wibration with non-linear damping ELECTRIC EQUIPMENT Analysis and calculation of lightning-ind woltages in aircraft electrical circuit [NASA-CR-2349]	wing A74-18834 e ads on ng A74-17185 A74-18297 uced s H74-14754	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Wilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/OGA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source [NASA-TH-I-71488] Research on noise generated by ducted air combustion systems	N74-13724 immersed power e field N74-13730 ibition N74-13752 image with te N74-14384 -fuel N74-14445
Some current problems and prospects for development of rotary-wing aircraft EJECTORS Thin-airfoil theory of an ejector-flapped section (AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure (DGLR PAPER 73-078) BLASTIC SYSTEMS Random vibration with non-linear damping ELECTRIC EQUIPMENT Analysis and calculation of lightning-ind voltages in aircraft electrical circuit [NASA-CR-2349] ELECTRODES A file thermocomple with a platinum elect	#ing A74-18834 e ads on ng A74-17185 A74-18297 uced s H74-14754	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/OGA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source [NASA-TM-I-71488] Research on noise generated by ducted air combustion systems [AD-767337]	N74-13724 immersed power e field N74-13730 ibition N74-13752 ance with e N74-14384 -foel N74-14445
Some current problems and prospects for development of rotary-wing aircraft EJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wirestructure [DGLR PAPER 73-078] BLASTIC SYSTEMS Random vibration with non-linear damping ELECTRIC EQUIPMENT Analysis and calculation of lightning-ind voltages in aircraft electrical circuit [MASA-CR-2349]	wing A74-18834 e ads on ng A74-17185 A74-18297 uced H74-14754 rode for	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-23637/0GA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise sourc [NASA-Th-I-71488] Research on noise generated by ducted air combustion systems [AD-767337] ENGIBE PARTS Non-destructive inspection of titanium jedisks	N74-13724 innersed power e field N74-13730 ibition N74-13752 iance with e H74-14384 -fuel N74-14445 et engine A74-16480
Some current problems and prospects for development of rotary-wing aircraft BJBCTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BODIES An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure [DGLR PAPER 73-078] ELASTIC SYSTEMS Random vibration with non-linear damping ELECTRIC EQUIPMENT Analysis and calculation of lightning-ind voltages in aircraft electrical circuit [MASA-CR-2349] ELECTRODES A film thermocouple with a platinum elect thermometry of gas turbine engine blade	#ing A74-18834 e ads on ng A74-17185 A74-18297 uced s H74-14754	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-23637/0GA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise sourc [NASA-Th-I-71488] Research on noise generated by ducted air combustion systems [AD-767337] BUGIBE PARTS Non-destructive inspection of titanium 16	N74-13724 immersed power e field N74-13730 ibition N74-13752 ance with e N74-14384 -fael N74-14445 et engine A74-16480 ction of
Some current problems and prospects for development of rotary-wing aircraft RJECTORS Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] ELASTIC BOILES An analytic approximate calculation of the nonlinear landing impact motions and local aircraft with both rigid and elastic wing structure [DGLR PAPER 73-078] ELASTIC SYSTEMS Random vibration with non-linear damping ELECTRIC EQUIPMENT Analysis and calculation of lightning-ind voltages in aircraft electrical circuit [NASA-CR-2349] ELECTRODES A film thermocouple with a platinum elect thermometry of gas turbine engine blade ELECTRON BEAM WELDING	wing 274-18834 e ads on ng A74-17185 A74-18297 uced R74-14754 rode for S A74-18686	Developmental design, fabrication, and te acoustic suppressors for fans of high b turbofan engines [NASA-CR-2338] Noise generation by cylindrical spoilers in an air duct analysis of acoustic output and directivity patterns of nois [AD-767336] Bilitary aircraft and airport noise and opportunities for reduction without inh of military missions [PB-223637/0GA] Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source [NASA-TH-I-71488] Research on noise generated by ducted air combustion systems [AD-767337] BUGIBE PARTS Non-destructive inspection of titanium jedisks Heat-resistant titanium alloys - Introduct the 651 A alloy	N74-13724 innersed power e field N74-13730 ibition N74-13752 iance with e H74-14384 -fuel N74-14445 et engine A74-16480
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Particle sampling and size analysis in the election zone of the Olympus let engine at ground level A74-17306 Ingestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [ATAA PAPER 74-42] Turbo let aircraft engine test cell pollution abatement study [AD-768287] AT4-18815 AT4-1306 AT4-1307 AT4-1306 AT4-1422 AT4-1306 AT4-1422 AT4-1306 AT4-1306 AT4-1422 AT4-1422 AT4-1422 AT4-1306 AT4-1422 AT4-1306 AT4-1422 AT4-1422 AT4-1306 AT4-1422 AT4-1306 AT4-1422 AT4-1422 AT4-1306 AT4-1422 AT4-1306 AT4-1422 AT4-1306 AT4-1422 AT4-1306 AT4-1422 AT4-1421 AT4-1422 AT4-1422 AT4-1422 AT4-1422 AT4-1422 AT4-1422 A	- The Olympus case	, or on dance	
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Ingestion and dispersion of enqine exhaust products by trailing vortices for supersonic flight in the stratosphere [ATAA PAPER 74-42] A74-18815 [ATAF PAPER 74-42] A74-18815 [ATAF PAPER 74-42] A74-18815 [ATAF PAPER 74-42] A74-18815 [ATAF PAPER 74-42] A74-13957 [ATAF PAPER 74-125] Atmospheric Pollution by Aircraft Engines [ATAF PAPER 74-125] Atmospheric Pollution by Premixing [ATAF PAPER 74-125] [ATAF PAP	drodug 16461		The drag of externally carried stores, 1+0
installations flight in the stratosphere [ATAN PAPER 74-42] AT4-18815 Turbofet aircraft engine test cell pollution abatement study [AD-768287] Atmospheric Pollution by Aircraft Engines [AGARD-CP-125] Reduction of NO forwations by premixing United States Department of Transportation research program for high altitude pollution N74-14272 Photo-oxidation of aircraft engine emissions at low and high altitudes N74-14277 Pffect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport Problems of chemical pollution by aircraft. The airport and its immediate environment Pollution control of airport engine test facilities INT4-14281 Installations N74-14729 Hethods for reducing vibrations of equipment mounted on belicopter external stores stations N74-14771 Hethods for reducing vibrations of equipment mounted on belicopter external stores stations N74-14771 In-flight stabilization of externally slung evaluation of candidate stabilizing systems (AD-768774) In-flight stabilization of externally slung evaluation of candidate stabilizing systems (AD-769063) EXTERNALLY BLOWN FLAPS Preliminary wind tunnel noise measurements of a semi-span ving with an upper-surface blown-flap (AIAA PAPER 74-191] Wind tunnel investigation of a large-scale 25 deg swept-wing jet transport model with an external blowing triple-slotted flap [MASA-TEX-6297] STOL tactical aircraft investigation, externally blown flap, Volume 1: Aerodynamic trades of flap and roll control system [AD-769763]	Indestion and dispersion of engine exha-		prediction and alleviation drag reduction by
Turbojet aircraft engine test cell pollution abatement study [AD-768287] Atmospheric Pollution by Aircraft Engines [AGARD-CP-125] Reduction of MO forwations by premixing W74-14271 Photo-oxidation of aircraft engine emissions at low and biqh altitudes M74-14277 Problems of chemical model with transport Problems of chemical pollution by aircraft. The airport and its immediate environment Pollution control of airport engine test facilities M74-14281 Pollution control of airport engine test facilities M74-14281 Pollution control of airport engine test facilities M74-14281 Bethods for reducing vibrations of equipment mounted on helicopter external stores stations mounted on helicopter external stores stations damping of vertical vibrations of equipment mounted on helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-768774] In-flight stabilization of externally slung helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-768774] In-flight stabilization of externally slung evaluation of candidate stabilizing systems [AD-768774] In-flight stabilization of externally slung evaluation of candidate stabilizing systems [AD-768774] In-flight stabilization of externally slung evaluation of candidate stabilizing systems [AD-768774] In-flight stabilization of externally slung evaluation of candidate stabilizing systems [AD-768978] In-flight stabilization of externally slung evaluation of candidate stabilizing systems [AD-769063] EXTERMALLY BLOWN PLAPS Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] In-flight stabilization of externally slung evaluation of candidate stabilizing systems [AD-769063] EXTERMALLY BLOWN PLAPS Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] In-flight stabilization of aircraft engine emissions at semi-span wing with an upper-surface blown-flap [AIAA PAP	flight in the stratosphere [Alah Paper 74-42]	ersonic	INSTALLATIONS
Atmospheric Pollution by Aircraft Engines [AGARD-CP-125] Reduction of MO forwations by premixing W74-14271 United States Department of Transportation research program for high altitude pollution N74-14273 Photo-oxidation of aircraft engine emissions at low and bigh altitudes W74-14277 Pffect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport W74-14278 Problems of Chemical pollution by aircraft. The airport and its immediate environment R74-14281 Pollution control of airport engine test facilities W119-104271 Wing-mounted stores on AB-16 helicopter [AD-768774] In-flight stabilization of externally slung helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-769063] EXTERMALLY BLOWN PLAPS Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] Wing-mounted stores on AB-16 helicopter [AD-768774] In-flight stabilization of externally slung helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-769063] EXTERMALLY BLOWN PLAPS Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] Wind tunnel investigation of a large-scale 25 deg [ABSA-TB-X-62197] STOL tactical aircraft investigation, externally blown flap, Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system	Turbojet aircraft engine test cell pollu abatement study	ition	methods for reducing vibrations of equipment mounted on helicopter external stores stations damping of wortical vibrations of
[ABARD-CP-125] Reduction of NO forwations by premixing W74-14271 United States Department of Transportation research program for high altitude pollution N74-14273 Photo-oxidation of aircraft engine emissions at low and high altitudes W74-14277 Pffect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport W74-14278 Problems of chemical pollution by aircraft. The airport and its immediate environment R74-14281 Pollution control of airport engine test facilities W74-14271 In-flept stabilization of externally slung helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-768774] In-flept stabilization of externally slung helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-768774] In-flept stabilization of externally slung helicopter loads design, development, and evaluation of candidate stabilizing systems [AD-768774] W74-14272 WATA-14273 WATA-14273 WATA-14274 WATA-14275 WATA-14275 WATA-14276 WATA-14277 WATA-1427	Atmospheric Pollution by Aircraft Pagine	N74-13957	wing-mounted stores on AB-1G helicopter
United States Department of Transportation research program for high altitude pollution Photo-oxidation of aircraft engine emissions at low and high altitudes M74-14277 Pffect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport Problems of chemical pollution by aircraft. The airport and its immediate environment Follution control of airport engine test facilities W74-14281 Follution control of airport engine test facilities W74-14272 W74-14273 M74-14274 M74-14281 H874-14281 Follution control of airport engine test facilities	#G#KD=CP=125		[AP-/08//4] was abase
United States Department of Transportation research program for high altitude pollution Photo-oxidation of aircraft engine emissions at low and high altitudes N74-14277 Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport Problems of chemical pollution by aircraft. The airport and its immediate environment R74-14281 Pollution control of airport engine test facilities WA4-14281 FOR TRANSPORT STANSPORT S		1277-14070	Acticopter loads design development
Photo-oxidation of aircraft engine emissions at low and high altitudes N74-14277 Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport Problems of chemical pollution by aircraft. The airport and its immediate environment Follution control of airport engine test facilities EXTERMALLY BLOWN FLAPS Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap (AIAA PAPER 74-191) Wind tunnel investigation of a large-scale 25 deg swept-wing jet transport model with an external blowing triple-slotted flap [RASA-TH-X-62197] STOL tactical aircraft investigation, externally blown flap, Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system [APA-14281]	United States Department of Transportati		evaluation of candidate stabilizing systems
Photo-oxidation of aircraft engine emissions at low and high altitudes N74-14277 Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport Problems of chemical pollution by aircraft. The airport and its immediate environment Follution control of airport engine test facilities Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAM PAPER 74-191] N74-14277 Wind tunnel investigation of a large-scale 25 deg swept-wing jet transport model with an external blowing triple-slotted flap [NASA-TM-X-62197] N74-14281 Follution control of airport engine test facilities Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAM PAPER 74-191] N74-14277 Wind tunnel investigation of a large-scale 25 deg swept-wing jet transport model with an external blowing triple-slotted flap [NASA-TM-X-62197] N74-14278 Freliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAM PAPER 74-191] N74-14277 Wind tunnel investigation of a large-scale 25 deg swept-wing jet transport model with an external blowing triple-slotted flap [NASA-TM-X-62197] STOL tactical aircraft investigation, externally blowing triple-slotted flap [NASA-TM-X-62197] STOL tactical aircraft investigation, externally blowing triple-slotted flap [NASA-TM-X-62197]	research program for high altitude pol	lution	EXTERNALLY BLOWN PLAPS
Problems of chemical pollution by aircraft. The airport and its immediate environment Pollution control of airport engine test facilities NAM-14281 Professional pollution by aircraft aircraft investigation, externally blown flap, volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system NAM-14281 NAM-14	Photo-oxidation of aircraft engine emiss low and high altitudes	N74-14273 ions at	Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap
layer, studied in a two-dimensional photochemical model with transport N74-14278 Problems of chemical pollution by aircraft. The airport and its immediate environment N74-14281 Pollution control of airport engine test facilities N74-14281 Sale transport model with an external blowing triple-slotted flap N74-13721 STOL tactical aircraft investigation, externally blown flap, Volume 1: Configuration N74-14281 Galletian Supplement 1: Aerodynamic trades of flap and roll control system CAD-7677791 CAD-767791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-7677791 CAD-767791 CAD-767791 CAD-767791 CAD-767791 CAD-767791 CAD-767791 CAD-767791 CAD-767791 CAD-767791 CAD-76	Effect of supergonic transmiss	N74-14277	Wind tunnel investigation of a large-scale 25 dec
Problems of chemical pollution by aircraft. The airport and its immediate environment Pollution control of airport engine test facilities R74-14281	tures Studied in a turediscocional	ozone	Swept-wing jet transport model with an external blowing triple-slotted flap
Pollution control of airport engine test facilities Area 14261 Follution control of airport engine test facilities Area 14261 Follution control of airport engine test facilities Area 14261 Follution control of airport engine test facilities Area 14261 Follution control of airport engine test facilities Follution control of airport engine test facilities	Problems of chemical pollution by singre	N74-14278 ft. The	STOL tactical aircraft investigation externally
Polition control of airport engine test facilities [Ab-767179]	airport and its immediate environment		PAUSE IIAD. VOINGO 1. CANFIANTAIA.
	Pollution control of airport engine test	facilities	fin-7c2+703

	Evaluation of aircraft departure divergence
STOL tactical aircraft investigation, externally	criteria with a six-degree-of-freedom digital
blown flap, Volume 5, part 1: Control system	simulation program
mechanization trade studies	74-18882
[AD-767181] STOL tactical aircraft investigation, externally	a pylon to decrease the effects of external stores
blown flap, Volume 5, part 3: Stability and	on the stability of aircraft
control derivative accuracy requirements and	
effects of augmentation system design	Development of techniques to measure in-flight
[AD-767182] H74-13757	drag of a US Navy fighter airplane and
(correlation of flight measured drag with wind
F	tunnel data N74-14734
ı	Definition of study objectives for integrated crew
P-14 AIRCHAFT	sodule development
Production data package 267 gallon external fuel	[AD-769065] H74-14773
tank Y-14 aircraft	BY E COOTTEC
[AD-767937] K74-13745	westerstion and optimization of the film COOLING
P-89 AIRCRAFT	requirements in a das turbine combustion chamber
Analysis and calculation of lightning-induced	(ADINDIDIDIDES 1 19437
voltages in aircraft electrical circuits	a proposed method for calculating film-cooled wall
[BR7F_C#_\$745)	temperatures in qas turbine combustion chambers
F-104 AIRCRAFT Performance of a ballute decelerator towed behind	[CRAMFIELD-SME-4] N/4-14440
	PTOTOS DIPPERRUCE THROST
a jet airplane [NASA-TM-X-56019] N74-14760	Calculation of separated flows at subsonic and
PAILURE ANALYSIS	transonic speeds
Theory and practice of avionics reliability	A74-16965
A /4= 10071	Three dimensional supersonic flow field analysis
A self-reorganizing digital flight control system	of the B-1 airplane by a finite difference
for aircraft	technique and comparison with experimental data
[AIAA PAPER 74-21] A74-18808	ETER ENERGY 14 103 1
Failure analysis of helicopter external	FINITE ELEMENT METROD NASTRAN data generation of helicopter fuselages
cargo-handling systems	using interactive graphics preprocessor
ran=767254] N74=13729	system for finite element analysis using IBM
Engineering appraisal of Southwest Research	
Institute magnetic crack definer applied to CH47	computer 874-14621
rotor blades	FIRED WINGS
[AD-769068] H74-14778	Fixed wing aircraft
Major Item Special Study (MISS), AH-16 driveshaft	374-18176
assembly, main transmission to engine	Automatic flight controls in fixed wing aircraft -
	The first 100 years
Failure modes, effects and criticality analysis (FBBCA) of category III instrument landing	A74-18296
system with traveling: Wave localizer antenna	PLANES
[U1-840912-100] K74-15380	Titanium flamecutting reduces airframe costs
[0]-040312-100]	
911100 BANKS	A74-16760
PAILURE EODES Pailure experience with and failure apticipation	DI ADDITAL
Failure experience with and failure apticipation	PLAPPING Concents for a theoretical and experimental study
PAILURE HODES Pailure experience with and failure anticipation in titanium components A74-16476	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations,
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] N74-14756
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES)
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURPACES) Inviscia wake-airfoil interaction on aultielement
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (COMPROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application A74-16513 Fretting resistant coatings for titanium alloys A74-16592	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513 Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513 Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap joints	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (COMPROL SUBFACES) Inviscid wake-airfoil interaction on multielement high lift systems PLAT PLATES Heat transfer investigation in a high-temperature
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap ioints A74-16696	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations; Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513 Pretting resistant coatings for titanium alloys Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations; Phase 2 [NASA-CR-114708] N74-14756 FLAPS (COMPROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513 Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap joints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational	PLAPPING Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations; Phase 2 [NASA-CR-114708] N74-14756 FLAPS (COMPROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations; Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FILAT PLATES Heat transfer investigation in a high-temperature question spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application A74-16513 Pretting resistant coatings for titanium alloys Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] FLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] A74-18843
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application 174-16513 Fretting resistant coatings for titanium alloys Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-18086 Fracture mechanics /Dryden lecture/ aerospace	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (COMTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems 74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-18086 Practure mechanics /Dryden lecture/ aerospace structural design applications	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-18086 Practure mechanics /Dryden lecture/ aerospace structural design applications	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] FILIPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FILIT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard confidurations [AIAA PAPER 74-69] A74-18813
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Wehicle Ride Control (CCV RCS).
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap ioints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Fracture, mechanics /Dryden lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] H74-14445	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16592 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18082 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TISTS A 300 B static and fatigue tests	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] FLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] FLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] N74-14756 PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] A74-18643 FLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] N74-13726
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-16755	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] FLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] FLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-16755 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] FLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] FLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE Bide cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap ioints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18085 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-1675: A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] N74-14756 PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE Bigh cycle fatique properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Evaluation of methods for reducing fretting fatique damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18085 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-220] Life of fatique cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatique tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-1675: A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in PTOSPIER ALECEAPT	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] N74-14756 PLAPS (CONTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] A74-1881 Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions FLIGHT COMDITIONS
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Fretting resistant coatings for titanium alloys Bvaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap ioints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in Fracture, mechanics /Dryden lecture/ aerospace structural design applications [A1AA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] FATIGUE TESTS A 300 B static and fatigue tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-1808: FIGHTER ALBCRAFT FF-16 stresses advanced technology design of	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A 544-16755 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in PIGHTER ALBCRAFT If 16 stresses advanced technology design of lightweight fighter	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions N74-14735 PLIGHT COMDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Fracture, mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-1675: A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-1806: PIGHTER AIRCRAFT IF-16 stresses advanced technology design of lightweight fighter	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708]
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE Bide cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap ioints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18085 Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-18089 FIGHTER AIBCRAFT FIGHTER AIBCRAFT FIGHTER AIBCRAFT Application of advances in structures and	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface A74-18684 Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT CONTROL Design and hower-flight testing of a deflection
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Practure, mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-16756 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-18086 PIGHTER AIRCRAFT VF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the VF-17 airplane [SUP paper 73891]	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMPITIONS Dispersion and dilution of jet aircraft erhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT CONTROL Design and hover-flight testing of a deflection control system for the Merodyne wingless,
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in A74-18086 Practure, mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-16756 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-18086 PIGHTER AIRCRAFT VF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the VF-17 airplane [SUP paper 73891]	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT CONDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT CONTROL Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle
Pailure experience with and failure anticipation in titanium components A74-16476 FATIGUE LIFE Bigh cycle fatigue properties of titanium in aircraft application Fretting resistant coatings for titanium alloys A74-16513 Fretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap ioints A74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in Fracture, mechanics /Dryden lecture/ aerospace structural design applications (A1AA PAPER 74-230) Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] FATIGUE TESTS A 300 B static and fatigue tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in FIGHTER ALBCRAFT FF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the FF-17 airplane [SAR FAPER 730891] Two numerical methods to solve realistic	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMBITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions [AIAA PAPER 74-41] PLIGHT CONTROL Design and hower-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle fDGLR PAPER 73-070] A74-1717
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatigue properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatigue damage in 2024-T3 aluminum lap 10ints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in Practure, mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] Life of fatigue cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatigue tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in A74-1808 PIGHTER AIBCRAPT IF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the YF-17 airplane [SAR PAPER 730891] Two numerical methods to solve realistic air-to-air combat differential quames A74-1873 A74-1873	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (COMTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMDITIONS Dispersion and dilution of jet aircraft erhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT COMTROL Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] The impact of area navigation on flight control
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE Bigh cycle fatique properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatique damage in 2024-T3 aluminum lap joints A 74-16696 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in Practure, mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatique cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatique tests A 74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in PIGHTEM AIBCRAFT YF-16 stresses advanced technology design of lightweight fighter Application of advances in structures and materials to the design of the YF-17 airplane [SAR PAPER 730891] Two numerical methods to solve realistic air-to-air combat differential games [AIAA PAPER 74-22] APPLICATION of damage tolerance technology to	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURFACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 FLAT PLATES Heat transfer investigation in a high-temperature question for supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT CONTROL Design and hover-flight testing of a deflection control system for the kerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] The impact of area navigation on flight control systems and displays
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatique properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatique damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatique cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatique tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in PIGHTER ALBCRAFT IF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the YF-17 airplane [SAE PAPER 730891] Two numerical methods to solve realistic air-to-air combat differential quages [AIAA PAPER 74-22] Application of damage tolerance technology to advanced metallic fighter wing structure	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (COMTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT CONDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT CONDITIONS Dispersion and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] The impact of area navigation on flight control systems and displays
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatique properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatique damage in 2024-T3 aluminum lap toints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatique cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatique tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in PIGHTER ALBCRAFT IF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the YF-17 airplane [SAE PAPER 730891] Two numerical methods to solve realistic air-to-air combat differential quages [AIAA PAPER 74-22] Application of damage tolerance technology to advanced metallic fighter wing structure	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (CONTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMDITIONS Dispersion and dilution of jet aircraft erhaust at high-altitude flight conditions [AIAA PAPER 74-41] PLIGHT COMPITIONS Dispersion and dilution of jet aircraft erhaust at high-altitude flight conditions [AIAA PAPER 74-41] PLIGHT COMPOL Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] The impact of area navigation on flight control systems and displays A74-1727 Bulti-surface system for the CCV B-52 Control
Pailure experience with and failure anticipation in titanium components A74-16476 PATIGUE LIFE High cycle fatique properties of titanium in aircraft application Pretting resistant coatings for titanium alloys A74-16513 Pretting resistant coatings for titanium alloys A74-16592 Evaluation of methods for reducing fretting fatique damage in 2024-T3 aluminum lap ioints A74-16696 A study of the damageability of turbine blades of aircraft qas-turbine engines after operational running in Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] Life of fatique cracks on rotor blades of turbines in gas turbine engines [AD-767947] PATIGUE TESTS A 300 B static and fatique tests A74-1675 A study of the damageability of turbine blades of aircraft gas-turbine engines after operational running in PIGHTER ALBCRAFT IF-16 stresses advanced technology design of lightweight fighter A74-1679 Application of advances in structures and materials to the design of the YF-17 airplane [SAR PAPER 730891] Two numerical methods to solve realistic air-to-air combat differential qames [AIAA PAPER 74-22] Application of damage tolerance technology to advanced metallic fighter wing structure	Concepts for a theoretical and experimental study of lifting rotor random loads and vibrations, Phase 2 [NASA-CR-114708] PLAPS (COMTROL SURPACES) Inviscid wake-airfoil interaction on multielement high lift systems A74-18143 PLAT PLATES Heat transfer investigation in a high-temperature gas flow spreading over a plane surface Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus [AIAA PAPER 74-14] PLIGHT CHARACTERISTICS Trimmed drag and maximum flight efficiency of aft tail and canard configurations [AIAA PAPER 74-69] Control Configured Vehicle Ride Control (CCV RCS). B-52 control system analysis, synthesis, and design [AD-767590] Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel predictions PLIGHT COMDITIONS Dispersion and dilution of jet aircraft exhaust at high-altitude flight conditions [AIAA PAPER 74-41] FLIGHT COMTROL Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] The impact of area navigation on flight control systems and displays

PLIGHT INSTRUMENTS SUBJECT INDEX

Control Configured Vehicle Ride Control (CCV RCS).	A guick look at the state-of-the-art in flight
8-52 Control system analysis, synthesis, and	testing of certain aerodynamic parameters
design	related to wind tunnel testing
(AD-767590) N74-13728 US Army belicopter hydraulic servocylinder	[FFA-NU-966]
reliability and maintainability investigation	EPL-10 lifting body flight control system
	characteristics and operational experience
STOL tactical aircraft investigation, Volume 5:	[NASA-TH-X-2956] N74-14753
Plight control technology	Ground operation tests of flying test bed for WTOL
[AD-767364] N711-12725	aircraft at National Aerospace Laboratory [NAL-TR-319]
Flight control of airplanes and heliconters	(NAL-TR-319) N74-14764 Comparison of the flying qualities of the A-7D
[AD-767943] n7a_12720	aircraft with the requirements of MIL-F-8785B ASG
A modified design concept, utilizing deck motion	
prediction, for the A-7E automatic carrier	LDP powered balloon program feasibility
landing system	demonstration of free balloon station keeping
[AD-767691] N74-13739	Capability
Tactile display for aircraft control [AD-767763] N74-13781	[AD-768673] N74-14770
The design and flight evaluation of a performance	Evaluation of the modified Bendix AAU 19A/A AIMS
control system general aviation aircraft	altimeter
under VPR conditions	[AD-768722] R79-15115 FLIGHT VEHICLES
[AD-767786] x7h_427hs	The determination of non-symmetric vehicle
A computer program for aircraft optimal control	stability parameters from response data
bropres.	
[AD-767919] N74-13750	FLOW N74-13702
Section 2: Flight mechanics, flight control	Drag and separation effects of separated flow
N7(1 1) 440	on aerodynamic drag
Calculation and analysis of aircraft motion various quidance methods and numerical solution	N74=16722
of optimal control theory problems	PLOW CHARACTERISTICS
	Characteristics of the wake behind a cascade of
HPL-10 lifting body flight control system	airfoils
characteristics and operational experience	1 A74-17495
I NASA-TE-X-2956] N74-14753	Improvement of the downflow conditions behind an integrated shrouded propeller
FLIGHT INSTRUMENTS	
Evaluation of the modified Bendix AMU 191/1 AIMS	A method of calculating the flow around a wing of
grtimetél	arbitrary planform, positioned on a cylindrical
(AD-768722) N74-15115 FLIGHT MECHANICS	body
Deutsche Forschunge- und Beneunt	174-18632
Deutsche Forschungs- und Versuchsanstalt ruer Luft- und Raumfahrt, Annual Report 1972	Dynamic stall
German book	[NASA-CR-136473] N74-13709
174_47950	Aerodynamic Drag
Section 2: Flight mechanics, flight control	[AGARD-CP-124] N74-14709 PLOW DISTRIBUTION
N74-18669	
FLIGHT OPTIBIZATION	Experimental investigation of sonic boom propagation through variable flow fields
On the fuel optimality of cruise for aircraft	174-16385
FLIGHT SAPETY A74-18142	Three dimensional supersonic flow field analysis
The influence of vice line to	OI the B-1 dirplane by a finite difference
The influence of wing loading on turbofan powered STOL transports with and without externally	technique and comparison with experimental data
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blown flans	[ALAA FAFEK /4-189] 37/1_10077
[NASA-CR-2320]	The flow field and pressure distribution of an
[NASA-CR-2320]	(ALMA PAPER /4-189) The flow field and pressure distribution of an isolated road wheel
[NASA-CR-2320] N74-13718 Section 2: Flight mechanics, flight control N72-18669	The flow field and pressure distribution of an isolated road wheel
[NASA-CR-2320]	[ALMA PAPER /4-189] The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the noblinear aerodynamics of hoding in
FIGURE 11aps [NASA-CR-2320] Section 2: Flight mechanics, flight control N74-14669 Aerotechnology in aviation problems N74-14675	[ALMA PAPER /4-1897] The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the noblinear aerodynamics of bodies in nopplanar motion numerical analysis of
N74-13718 N74-13718 N74-13718 Section 2: Flight mechanics, flight control N74-14669 N74-14675 N74-14	The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of aerodynamic force and moment systems during
FLIGHT SIMULATION A 300 B static and fatique tests	The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of aerodynamic force and moment systems during large amplitude, arbitrary motions [BASA-TR-R-421]
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FLIGHT SIMULATION A 300 B static and fatique tests Dynamic test of air data computers with simulated	The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of aerodynamic force and moment systems during large amplitude, arbitrary motions [MASA-TR-R-421] Analysis of the flow about delta wings with leading edge separation at supersonic speeds
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FLIGHT SIMULATION A 300 B static and fatigue tests Dynamic test of air data computers with simulated flight profiles Vertical take-off and landing aircraft N74-18178	The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of aerodynamic force and moment systems during large amplitude, arbitrary motions [MASA-TR-B-421] Analysis of the flow about delta wings with leading edge separation at supersonic speeds [MASA-CR-132358] Similarity parameters and their sensitivity for transonic airframe exhaust nozzle interactions
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Section 2: Flight mechanics, flight control Section 2: Flight mechanics, flight control Aerotechnology in aviation problems PLIGHT SIMULATION A 300 B static and fatique tests Dynamic test of air data computers with simulated flight profiles Vertical take-off and landing aircraft PLIGHT TESTS Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] Vertical take-off and landing aircraft A method of calculating aircraft wake velocity profiles and comparison with full-scale experimental measurements [AIMA PAPER 74-39] Aerotechnology in aviation problems N74-18747 Problems of estimating the drag of a helicopter correlation of flight test data and scale model test data R74-14715 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel	The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of aerodynamic force and moment systems during large amplitude, arbitrary motions [WASA-TR-N-421] Analysis of the flow about delta wings with leading edge separation at supersonic speeds [NASA-CR-132358] Similarity parameters and their sensitivity for transonic airframe exhaust nozzle interactions [AD-768988] FLOW EQUATIONS The determination of non-symmetric vehicle stability parameters from response data FLOW GEOMETRY A direct method for computing the steady flow at Mach number one past a given wing airfoil FLOW MEASUREMENT A relaxation method for calculating transonic flows with detached bow shocks A74-16970 Artificial development of an atmospheric boundary layer flow model in a wind tunnel using wind flow modulating devices at wind tunnel entrance FLOW STABILITY Experimental study of the internal noise in injector driven wind tunnels [OBERA, TP NO. 1315] FLOW VISUALIZATION FLOW VISUALIZATION 1 1470-14706 1874-14706 1874-14741
Section 2: Flight mechanics, flight control Section 2: Flight mechanics, flight control Aerotechnology in aviation problems PLIGHT SIMULATION A 300 B static and fatique tests Dynamic test of air data computers with simulated flight profiles Vertical take-off and landing aircraft PLIGHT TESTS Design and hover-flight testing of a deflection control system for the Aerodyne wingless, remote-controlled experimental flight vehicle [DGLR PAPER 73-070] Vertical take-off and landing aircraft A method of calculating aircraft wake velocity profiles and comparison with full-scale experimental measurements [AIMA PAPER 74-39] Aerotechnology in aviation problems N74-18747 Problems of estimating the drag of a helicopter correlation of flight test data and scale model test data R74-14715 Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel	The flow field and pressure distribution of an isolated road wheel [IC-AERO-72-14] A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of aerodynamic force and moment systems during large amplitude, arbitrary motions [HASA-TR-R-421] Analysis of the flow about delta wings with leading edge separation at supersonic speeds [HASA-CR-132358] Similarity parameters and their sensitivity for transonic airframe exhaust nozzle interactions [AD-768988] FLOW EQUATIONS The determination of non-symmetric vehicle stability parameters from response data PLOW GEOMETRY A direct method for computing the steady flow at mach number one past a given wing mirfoil PLOW BEASUREMENT A relaxation method for calculating transonic flows with detached bow shocks Artificial development of an atmospheric boundary layer flow model in a wind tunnel using wind flow modulating devices at wind tunnel entrance PLOW STABILITY EXPERIMENT EXPERIMENT EXPERIMENT ATA-18288

Wind tunnel dynamic analysis of an oscillat	ing	FUEL CONTROL	
airfoil		Models in the design of fuel systems	A74-16758
[AIAA PAPBR 74-259] Bagnus characteristics of arbitrary rotation	174-18666 a hodies	FOEL TABES	
fagard-ag-1711	N/4-13/10	Models in the design of fuel systems	A74-16758
The stability of helical vortex filaments i	n the	Production data package 267 gallon externa	
wake of a hovering rotor	N74-13713	tank F-14 aircraft	
FLUID DYNAMICS		[AD-767937]	N74-13745
Dentache Porschungs- und Versuchsanstalt fü	er	PULL SCALE TESTS A method of calculating aircraft wake velocing	city
Luft- und Raumfahrt, Annual Report 1972 -	· 	profiles and comparison with full-scale	
German book	A74-17969	erperimental measurements	A74-18747
PLUID INJECTION		[AIAA PAPER 74-39] PUSBLAGES	
Experimental study of the internal noise in injector driven wind tunnels	l	wanufacturing exercise involved in the red	esign of
[ORBRA, TP NO. 1315]	A74-18288	the Hawker Siddeley Trident /tri-1et/ fu	874-16445
PTOTPER ANALYSTS		Experimental study of metal-plastic coupli	
Lifting-Surface theory for an oscillating T	174-17012	tension	A74-18648
A direct method for calculating flutter spe	eds	Investigations concerning wing-fuselage	M74-10040
(AIAA PAPER 74-27) On repetitive flutter calculations in struc	A/4-100/3	interference in the case of subsonic vel	ocity
deetan			A/4-1889/
(ATA) DADER 74-1411	A74-18789	Optimization and design of the rear fusela the A 300 B aircraft structure	de or
Theoretical investigation of supersonic flooscillating cascades with subsonic leading	ng-edge		N74-15614
locus		G	
[AIRA PAPER 74-14]	A74-18843	G	
Analysis of stall flutter of a helicopter to blade	radar	GAME THEORY	
FN1SA-CR-23221	N74-13708	Two numerical methods to solve realistic air-to-air combat differential games	
Effect of compressibility on three-dimension helicopter rotor blade flutter	pnaı	[AIAA PAPER 74-22]	A74-18736
	N74-13714	GAS FLOW	orature
Transonic single-mode flutter and buffet of	E a low	Heat transfer investigation in a high-temp gas flow spreading over a plane surface	CLUCULO
aspect ratio wing having a subsonic airfo	911 SMADE 974-14631	·	A74-18684
. Flutter computer program and lifting surface		GAS TURBINE REGIERS Not-salt stress-corrosion of titanium allo	VS AS
theory with boundary layer	N74-14707	related to turbine engine operation	
[NASA-CH-136559] PLY BY WIRE CONTROL		•	A74-16600
Application of the aerospace Bultiprocessor	r to the	In approach toward optimizing material cos part function in advanced powerplants	ic and
A-TD flight control system developmed digital fly-by-wire system	nt or	SAE PAPER 7309091	A74-17535
[AD-768382]	N74-14769	The T700-GE-700 turboshaft engine program	A74-17536
POC	nles of	(SME PAPER 730917] The problem of optimal design of gas-turbi	
Thermal and chemical fog dissipation: Res field experiments at Vandenberg AFB, Cal	ifornia		A/4-18083
during July 1972		A study of the damageability of turbine bl aircraft gas-turbine engines after opera	ades of tional
[AD-768671]	N74-15367	running in	
FORGING Status of the latest turbine disk alloys i	n the U.S		174-18085
	A74-17890	Suitability of using titanium pipelines in hydraulic systems of turbine engines	
PRACTURE MECHANICS Practure mechanics /Dryden Lecture/ ae	rospace	·	A74-18090
structural design applications		A film thermocouple with a platinum electr thermometry of qas turbine engine blades	ode for
[AIAA PAPER 74-230]	A74-10858		Y/4-18090
PRACTURE STREEGTH Evolution of applications of precision cas	ting in	Parameters controlling nitric oxide emissi	lons from
turbojets	A74-17892	qas turbine combustors	N74-14291
FRECE	# 14- 1102E	Pactors controlling pollutant emissions for	rom das
Supersonic compressor test facility	- 75 40600	turbine engines	N74-14292
PRECORNCY DIVISION MULTIPLEXING	A74-18603	Estimation and optimization of the film co	poling
microwage Landing System (MLS) development	plan as	requirements in a gas turbine combustion	n chamber N74-14439
proposed by Paytheon during the techB1qU	le	(CRANFIELD-SME-5) A proposed method for calculating film-co	
analysis and contact definition phase of national MLS development program. Volum	: тше ie 3:	temperatures in gas turbine combustion	chambers
1,1.1 performance validation		[CRANFIELD-SME-4] Blade dynamics analysis using NASTRAN	N/4-1444L
[FAA-RD-73-150-3]	N74-15382	of blade geometry, temperature gradient:	s, and
PRETTING CORROSION Failure experience with and failure antici	pation	rotational speed	
in titarium components		GAS TURBINES	N74-14599
Fretting resistant coatings for titanium a	174-16476 allows	Some specific characteristics of small qa	s
	A74-16592	turbines and the modeling problems of t	heir wind
Evaluation of methods for reducing fretting	ig fot st s	tunnel testing	A74-18682
fatique damage in 2024-T3 aluminum lap	1010ts 274-16696	Improved silicone fluids as candidate que	turbine
PUBL COMBUSTION		engine oils for winus 40 F to 465 F tem	perature
The jet engine design that can drastically	Legace	range [AD-767898]	N74-14246
oxides of mitrogen [AIAA PAPER 74-160]	A74-18797	A preliminary study on the influence of f	uel
On the fuel optimality of cruise for		staging on nitric oxide emissions from turbine combustors	qas

Aircraft qas turbine pollutant limitations oriented toward minimum effect on engine performance	Operational evaluation of the 5K-5 air cushion vehicle in Alaska
#74-14304 Modeling a high pressure ratio centrifugal	(AD-768781) H74-1477 GROUND SUPPORT EQUIPMENT
compressor using a low speed of sound gas	Pollution control of airport engine test facilities 874-1428
Effect of increased fuel temperature on emissions	GUIDE VARES
or oxides of nitrogen from a gas turbine combustor burning ASTM jet-A fuel	The spectrum of turbomachine rotor noise caused by inlet quide vane wakes and atmospheric turbulence
[NASA-TH-X-2931] N74-15659 GRARS	GUST LOADS H74-1437
Reduction of vibration and noise generated by	Unsteady lift forces on highly cambered airfoils moving through a qust
planetary ring gears in belicopter aircraft transmissions	[AIAA PAPER 74-88] A74-1990
[ASME PAPER 73-PTG-11] 270-16070	An improved exceedance theory for combined random
Improved circumferential shaft seal for aircraft qear transmissions	stresses with application to aircraft qust response
[NASA-TN-D-7130] N74-14138	N74-14569
GENERAL ATIATION AIRCRAPT	H **
Q-FANSTM for general aviation aircraft [NASA-CR-114665] N74-13726	HARDENIEG (MATERIALS)
GENERAL DINABICS AIRCRAFT	Deep bardenable titanium alloys for large airframe
YF-16 stresses advanced technology design of lightweight fighter	elements
GLASS FIBER REIBFORCED PLASTICS A74-16793	BEAT RESISTANT ALLOYS
A sailplane wing constructed of foam core and	Status of the latest turbine disk alloys in the U.S.
polyester fiberglass skin	Heat-resistant titanium alloys - Introduction of
Experimental investigation of glass-plastic and	the 651 A alloy
metal-plastic joints under shear	HEAT TRANSPER A74-17891
GLIDE PATHS A74-18697	Ablation beat and mass transfer in hypersonic flight
Simplified Visual Approach Slope Indicator (VASI)	1711_174A2
operation test and evaluation [AD-767901] 874-14362	MEAT TRANSPER CORPFICIENTS
GLIDERS	Evaluation of the influence of errors in specifying boundary conditions on the accuracy
A sailplane wing constructed of foam core and polyester fiberglass skin	of the determination of temperature fields in infinite cylinders
[AIAA PAPER 74-258] A74-18665 A preliminary design of a remotely-controlled	174-10655
glider for a long-line operation	Heat transfer investigation in a high-temperature
[AD-767879] H74-13744 GOVERNMENT/INDUSTRY RELATIONS	gas flow spreading over a plane surface A74-18684
Government responsibility for damages in airplane	HELICOPTER CONTROL Rotary-wing aircraft
crash cases when weather is a factor	N71-40477
A74-18098 Aerotechnology in aviation problems	Automatic Plight Control System development for U.S. Army heavy lift helicopter
GRAPHITE H74-14675	[AIAA PAPER 74-251 174-10065
Graphite composite landing quar components - side	Automatic control of a helicopter with a hanging load development and evaluation of automatic
brace assembly and torque link for A37 B aircraft [AD-769041] #74-14779	pliot for use with S-61 helicopter
Development of a graphite horizontal stabilizer	[NASA-CR-136504] #74-13715 HELICOPTER DESIGN
structural analysis of static ultimate load and simulated fatique spectrum loading	Design and development support for critical
[AD-768869] #74_44703	helicopter applications in Ti-6A1-4V alloy
GROUND BASED CONTROL Future air traffic control - Ground, cockpit, or	Keduction of Vibration, and noise generated by
space system functions transfer to aircraft or satellites	planetary ring gears in helicopter aircraft transmissions
[AIAA PAPER 74-262] 174-19660	[ASBE PAPER 73-PTG-11] . AZR-46070
GROUND EFFECT	Heavy Lift Helicopter main engines 3c [SAE PAPER 730920] 174-17537
The jet-flapped wing in ground proximity with special allowance for large angle of attack and	Vehicle Crashworthiness rotary wing fixed
rande les mad audie	wing light and transport aircraft A74-17776
Nonlinear airfoil theory with allowance for ground	Rotary-wing aircraft
effects for aerodynamic interference problems solution	Vertical take-off and landing aircraft
17A-47220	Calculation of the dynamic characteristics of a
STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study	helicopter structure by the method of branch modes
! AD=767300 1 n7a +27ac	Helicopter modelling /18th Henson and Stringfellow
Ground operation tests of flying test bed for YTOL aircraft at National Aerospace Laboratory	recture, exploiatory, development and
NAU-IX-319 Nau-X-1	research models
Simplified alreraft performance methods: Power required for single and tandom roton believed	Some current problems and prospects for
In noter and totaled flight	development of rotary-wing aircraft
[AD-768769] N74-14777 GROUND EPPECT MACHINES	Determination of the basic parameters of light
Some results of an experimental cause of all	helicopters on the basis of the treatment and analysis of statistical data
DGLE PAPER 73-0691	17h_4060h
Turning Characteristics of the Rell 100 ton	1501ated airfoil - TIP vortex interaction noise
surface effect ship [AD-767680] H74-13753	(AIAA PAPER /4-194] 874-18831

MASTRAM data generation of helicopter fuselages	Materials for the new deneration of afficiant A74-17374
using interactive graphics preprocessor system for finite element analysis using IBE	HIGH TEMPERATURE GASBS
computer	Heat transfer investigation in a high-temperature gas flow spreading over a plane surface
N74-14621	que 1100 spreading 0421 à plane 541-18684
Similarity requirements for aeroelastic models of helicopter rotors	EL-10 REENTRY VEHICLE
[ARC-CP-1245] N74-14767	HFL-10 lifting body flight control system characteristics and operational experience
Helicopter inspection design requirements	[NASA-TH-I-2956] N74-14753
. (AD-769061) BELICOPTER ENGINES	HOBING DEVICES
The T700-GE-700 turboshaft engine program	Lasers - Ranger and marked target seeker A74-16756
[SAB PAPER 730917] A74-17536	RORTSONTAL TAIL SURFACES
Heavy Lift Helicopter main engines [5AB PAPER 730920] A74-17537	Measurements of rolling moments acting on the
Simplified aircraft performance methods: Power	stabilizer of T-tails oscillating in yaw [NAL-TR-324] N74-14744
required for single and tandem rotor helicopters	nevelopment of a graphite borizontal stabilizer
in hower and forward flight [AD-768769] N74-14777	structural analysis of static ultimate load
HELICOPTER PERFORMANCE	and simulated fatique spectrum loading [AD-768869] N74-14783
Dynamic stall N74-13709 N74-13709	HODE SAMAKATA
[WASA-CR-136473] N74-13709 Automatic control of a helicopter with a hanging	New concepts in AMTI radar → Nulling effects of
load development and evaluation of automatic	Doppler filter/multi-element horn array p74-17252
pilot for use with 5-61 helicopter	HOVERING
(MASA-CR-136504) New technologies and profitability of helicopters	The stability of helical vortex filaments in the
application of belicopters to commercial	wake of a hovering rotor 874-13713
operations (Wath-TH-151951 N74-13717	Simplified aircraft performance methods: Power
simplified aircraft performance methods: Power	required for single and tandem rotor helicopters
required for single and tandem rotor helicopters	in hover and forward flight [AD-768769] #74-14777
in hover and forward flight [AD-768769] R74-14777	HOVERING STABILITY
HRLTCOPTER PROPELLER DELYE	Some results of an experimental study of the
Recommended design modifications to the CH-47	Aerodyne concept by Dornier System GmbH [DGLR PAPER 73-069] A74-17178
forward rotor drive gearbox [AD-769062] 874-14775	nesign and hower-flight testing of a deflection
Major Item Special Study (MISS), AH-16 driveshaft	control system for the herodyne wingless, remote-controlled experimental flight wehicle
assembly, main transmission to engine	f ngle PAPER 73-070 1 A74-17179
[AD-768763] N74-1476C HELICOPTER WARES	Analysis of stall flutter of a helicopter radar
An unsteady wake model for a hingeless rotor	blade
A74-18190	RUMAN PACTORS REGINERRING
The stability of helical wortex filaments in the wake of a hovering rotor	 Definition of study objectives for integrated crew
B74-13713	module development [AD-769065] N74-14773
HELICOPTEES Analysis of stall flutter of a helicopter radar	HYDRAULIC EQUIPMENT
hlade	Suitability of using titanium pipelines in the
[NASA-CR-2322] N74-13708	hydraulic systems of turbine engines
Failure analysis of helicopter external cargo-handling systems	US Army helicopter hydraulic servocylinder
r nn=76725# 1 N74-13729	reliability and maintainability investigation
Transmission thermal mapping (CH-47C forward rotor	[AD-767243] HPI-10 lifting body, flight control system
transmission) [AD-767875] N74-13732	characteristics and operational experience
Plight control of airplanes and helicopters	[NASA-TK-X-2956] N74-14753
fin-767943] R/4-13/38	EYDEOCARBON FUELS. Supersonic fuels from medium oils produced by the
Orientation-error accidents in regular Army UH-1 aircraft during fiscal year 1970: Relative	thermal cracking of crude oil residues
incidence and cost	[DFVLR-SONDDR-301] A74-18925 BYDROGEN EMBRITTLEMENT
[AD-769307] #74-13742 Static and dynamic belicopter airframe analysis	Nondestructive detection of hydrides and
with WASTRAN	alpha-case in titanium alloys
N74-14616	A74-16482
<pre>Problems of estimating the drag of a belicopter correlation of flight test data and scale</pre>	The hydrogen fuel economy and aircraft propulsion
model test data	FATAA PAPER 73-13191 A/4-1/905
W74-14715	The jet engine design that can drastically reduce oxides of nitrogen
HELMHOLTZ VORTICITY EQUATION Analysis of three-dimensional unsteady flow around	[AIAA PAPER 74-160] A74-18797
oscillating wings	NYDROGENATION The refining of turbine fuels by modern
(AIAA PAPER 74-184) A74-18836	hydrotreating
HIGH ALTITUDE Dispersion and dilution of jet aircraft exhaust at	TATAA PAPER 74-162] A74-18798
high-altitude flight conditions .	Supersonic fuels from medium oils produced by the thermal cracking of crude oil residues
(AIAA PAPER 74-41) A74-18749	[DFVLR-SONDDB-301] 174-18925
HIGH ALTITUDE BALLOOMS The Bole balloons and air safety	HYPERBOLIC WAVIGATION
174-18596	Aircraft inertial system testing and evaluation in the United Kingdom
HIGH STRENGTH ALLOYS The use of ultra high strength titanium alloys in	N74-14352
a V/STOL military aircraft application - The H.	HYPERSONIC AIRCRAFT
S. A. Harrier	Optimal capabilities of hypersonic passenger aircraft on kerosene fuel
anglications of the high strength alloy	[AD-767887] H74-13737
Ti-4A1-4Mo-2Sn-0.5Si in European aircraft projects	
A74-16450	

BYPERSONIC FLIGHT	Microwave Landing System (MLS) development plan as
Ablation heat and mass transfer in hypersonic	proposed by AIL during the technique analysis
tliqht	and contract definition phase of the national
HIPERSONIC PLON	BLS development program. Part 1.0, Volume 1.2.
The effects of hypersonic viscous interaction on	Book 1: Post TACD development plan [PAA-RD-73-166-VOL-1.2,1-BK-1] #74-1434
static stability of slender bodies in simulated	Hicrowave Landing System (HLS) development plan as
non-equilibrium flows	proposed by AIL during the technique analysis
Aerodynamic Drag	and contract definition phase of the national
[AGARD-CP-124] N74-14709	MLS development program, Part 1.0, Volume 1.2, Book 2: Post TACD development plan
Drag in hypersonic rarefied flow effects of	[PAA-RD-73-166-VOL-1.2,2-BK-2] H74-1434
cold pressure drag and friction drag	Microwave Landing System (MLS) development plan as
N74-14730 Review of drag measurements from flight tests of	proposed by AIL during the technique analysis
manned aircraft with comparisons to wind-tunnel	and contract definition phase of the national
predictions	MLS development program. Part 3.0, Volume 3.1, Book 1: Compilation of critical technical area
N74-14735	reports
	[PAA-RD-73-166-VOL-3.1,1-BK-1] N74-1434
	Microwave Landing System (MLS) development plan as
ICE FORBATION	proposed by AIL during the technique analysis and contract definition phase of the national
On the modes of icing of symmetrical lifting	BLS development program, Part 3.0, Volume 3.1.
Surfaces	Book 2: Compilation of critical technical area
ICE REPORTING A74-18987	reports
Airborne profiling of ice thickness using a short	[PAR-RD-73-166-VOL-3.1,2-BK-2] N74-1434
pulse radar	derogation effects on the localizer portion of
TARAL BURNES A74-17810	the instrument landing system
IDEAL FLUIDS A method of calculating the flow around a wing of	[AD-768049] N76-1026
arbitrary planform, positioned on a cylindrical	Failure modes, effects and criticality analysis
body	(PRECA) of category III instrument landing system with traveling: Wave localizer antenna
174-18632	[U1~840912=100] w7h_4630/
IN-PLIGHT HOWITORING	Microwave Landing System (MLS) development plan as
Avionics design for maintainabílity - Are we gaining or losing	proposed by Raytheon during the technique
[SAE PAPER 7308821 370-47524	analysis and contract definition phase of the
Data acquisition, processing, and control for	national MLS development program. Volume 1: Executive summary
anvenced aircraft	[FAA-RD-73-150-1] #7/L-15201
[SAE PAPER 730957] A74-17542 INCOMPRESSIBLE FLOW	Microwave Landing System (MLS) development plan as
Development of a method of	Proposed by Havtheon during the technique
discretized-distribution singularities for the	analysis and contact definition phase of the national MLS development program. Volume 3:
study of compressible and incompressible flows	1.1.1 performance validation
INERTIAL HAVIGATION	[FAA-RD-73-150-31 #70-46305
Lasers - Ranger and marked target seeker	Microwave Landing System (MLS) development plan as
17h_16956	proposed by Raytheon during the technical analysis and contract definition phase of the
Aircraft inertial system testing and evaluation in	national MLS development program, Volume 3A
the United Kingdom	[FAA-KD-73-150-3A] w7n_45202
IMPRARED SPECTRA N74-14352	Microwave Landing System (MIS) development nian ac
Representation of hot jet turbulence by means of	proposed by Raytheon during the technique analysis and contract definition phase of the
its infrared emission	untional SLS development program. Volume he
[NASA-TT-P-15233] N74-14383	System Considerations 1.1.2 through 1.1.5
Problem of adapting an intake to a turbojet engine	FAA=RD=/3=150=41
for extremely high flight Bach numbers	Microwave Landing System (MLS) development plan as
174_47777	proposed by Raytheon during the technique analysis and contract definition phase of the
The effect of inlet distortion on the performance and stability of the low-speed spool of a	national MLS development program, volume 5.
turbofan engine	Post TA/CD plans, management performance
fATAA PAPER 74-2341	[PAA-RD-73-150-5] H74-15385
The Spectrum of turbomachine rotor major cances be	Microwave Landing System (MLS) development plan as proposed by Raytheon during the technique
inlet quide wane wakes and atmospheric turbulence	analysis and contract definition where of the
Assessment of the influence of inlet and	Dational DLS development program. Volume 6.
aftbody/mozzle performance on total aircraft drag	Supporting studies, appendices D through H
Vフルー 4 トラウム	[FAA-RD-73-150-6-APP-D-F] #74-15386
INLET MORSIES	Integral equation method for calculation of
Assessment of the influence of inlet and afthody/nozzle performance on total aircraft drag	SUDSORIC ILOW Dast Airfoils in a won+11stod wind
THEODERMAN H74-14726	tungs - Comparison with NAE high Revuolds
INSPECTIVE	number measurements (AIAA PAPER 74-83) A78-1876A
Relicopter inspection design requirements	INTERPERENCE DRAG
[AD-769061] H74-14781	The drag of externally carried stores: The
The Type 3B altitude measurement system	prediction and alleviation Area reduction by
170-4707 <i>c</i>	redesign or development of new aircraft
LEDIKUGANI LANDING SISPRES	installations
A new ILS localizer for regional airports	INTENTORY HANAGEMENT
Hicrowave Landing System (HLS) development plan as	Aircraft force protection model. Volume 1. Hoose
	quide to Afre computer program to determine
PUR CONTINCE COTINITION Where he are made	alreratt inventory and operating requirements
	[20-707940] 874-13751
f Pil-ph-72-1cc-vo-c-c-	•
174-14340	•

B74-14340

		The testing of jet engines, chapters 5 and	16
ISCID FLOW	element	test stand structure	
Inviscid wake-airfoil interaction on multi- high lift systems	eremen.	[AD-768492]	N74-15467
midt mitt placem	A74-18143	JET BIBLUST	rhaust at
ITALY	_	Dispersion and dilution of jet aircraft ex high-altitude flight conditions	Annast av
Porty years of civil aviation, 1931 - 1971	TOL	CATAR DEDPR 74-011	179-18749
Italy	n74-14750	voice generation by cylindrical spoilers :	immersed
ITERATIVE SOLUTION		in an air Anri analysis of acoustic	boast
Numerical investigation of vorter sheets i	ssuing	output and directivity patterns of nois	N74-13730
from a separation line near the leading	edge	[AD-767336] JET PLAPS	
	A74-18289	The int-flanned wing in ground proximity '	with
On repetitive flutter calculations in stru	Cultur	special allowance for large angle of at	tack and
design (AIAA PAPER 74-141)	A74-18789	large jet flap angle	A74-17221
(atta tatan iv iii)		Methods for the design and analysis of te	
1		Methods for the design and address of the airfoils	C-IIuppeu
		CATAR DADPR 74-1887	A74-18833
J-85 ENGINE Sonic inlet noise attenuation and performa	nce with	March 1971 wind tunnel tests of the Doran	a DH 2011
a J-05 turbojet engine as a noise source		jet flap rotor, volume 1	
[AIA PAPER 74-91]	174-18768	(MASA-CR-1146931	N74-13722
JRT ATRCRAPT		Harch 1971 wind tunnel tests of the Doran	Q DR 2011
Some results of an experimental study of t	he	jet flap motor, volume 2 [NASA-CR-114694]	N74-13723
Aerodyne concept by Dornier System GmbH	A74-17178	STOL tactical aircraft investigation. Vo	lune 2:
[DGLR PAPER 73-069]		Design compendium	
Dispersion and dilution of jet aircraft ex high-altitude flight conditions	Madot at	r nn-7675611	N74-13733
[AIAA PAPER 74-41]	A74-18749	Transonic drag due to lift of planar jet-	flapped
The Alpha Jet programme		airfoils	N74-14720
	A74-18902		B14" (4720
Wind tunnel investigation of a large-scale	25 deg	JET LIFT Lift-induced wing-tip wortex attenuation	
swept-wing jet transport model with an e	rternal	[AIAA PAPER 74-38]	A74-18852
blowing triple-slotted flap	874-13721	JET HOZZLES	
[RASA-TB-X-62197] JET AIRCRAFT WOISE	B14-13121	Jet noise modeling - Experimental study a	nd models
Hew jumbo jets must speak in whispers - Ce	ertifying	for the noise and turbulence fields	
the Lockheed 1011		(AIAA PAPER 74-3)	A74-18723
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Research on noise generated by ducted air- combustion systems [AD-767337] Plight velocity effects on jet noise of systems [AD-767337] Plight velocity effects on jet noise of systems wariations of a twelve-chute suppressor installed on a plug nozzle [MASA-TH-X-2918] Combustion generated noise in turbopropula systems [AD-768615] JET ENGINE FUBLS The refining of turbine fuels by modern hydrotreating [ATAA PAPER 74-162] Supersonic fuels from medium oils produce thermal cracking of crude oil residues [DFYLR-SONDER-301] Optimal capabilities of hypersonic passen aircraft on kerosene fuel [AD-767887] Problems of chemical pollution by aircraf airport and its immediate environment Ground contamination by fuel jettisoned f aircraft Effect of increased fuel temperature on e of oxides of pitrogen from a gas turbin combustor burning ASTM jet-A fuel [HASA-TH-X-2931] JET ENGINES Won-destructive inspection of titanium je disks The problem of installing a modern high h engine on a twin jet transport aircraft	#74-13730 -fuel #74-14445 everal #74-15466 sion #74-15666 #74-18798 # Dy the #74-18925 ger #74-13737 t. The #74-14281 row #74-14283 missions e #74-15659 et engine #74-16480 eypass #74-14727	EXALMAN FILTERS A self-reorganizing digital flight control for aircraft [AIAA PAPER 74-21] ERBOSENE Optimal capabilities of hypersonic passes aircraft on kerosene fuel [AD-767887] L-1011 AIRCRAFT L-1011 upkeep [SAE PAPER 730883] New jumbo lets must speak in whispers - the Lockheed 1011 LAMINAR WARES Inviscid wake-airfoil interaction on mulhigh lift systems LAND USE An innovative approach to airport planni LANDING AIDS The simulation and analysis of carrier 1 using a nonlinear pilot model [AD-767679] Microwave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n MLS development program. Part 1.0, vo Technique analysis program	a74-18808 nqer
Research on noise generated by ducted air- combustion systems [AD-767337] Plight velocity effects on jet noise of so variations of a twelve-chute suppressor installed on a plug nozzle [MASA-TH-X-2918] Combustion generated noise in turbopropula systems [AD-768615] JET ENGIME FUBLS The refining of turbine fuels by modern hydrotreating [ATAN PAPER 74-162] Supersonic fuels from medium oils produce thermal cracking of crude oil residues [DYVIR-SONDDR-301] Optimal capabilities of hypersonic passen aircraft on kerosene fuel [AD-767887] Problems of chemical pollution by aircraf airport and its immediate environment Ground contamination by fuel jettisoned f aircraft Effect of increased fuel temperature on e of orides of nitrogen from a gas turbin combustor hurning ASTM jet-A fuel [HASA-TH-I-2931] JET ENGIMES Hon-destructive inspection of titanium je disks The problem of installing a modern high h engine on a twin jet transport aircraft	#74-13730 -fuel #74-14445 everal #74-15466 sion #74-15666 A74-18798 d by the A74-18925 ger #74-13737 t. The #74-14283 missions e #74-15659 et engine A74-16480 eypass #74-14727 rr-intakes	MALHAN FILTERS A self-reorganizing digital flight control for aircraft [AIAA PAPER 74-21] ERROSENE Optimal capabilities of hypersonic passes aircraft on kerosene fuel [AD-767887] L-1011 AIRCRAFT L-1011 upkeep [SAE PAPER 730883] New jumbo jets must speak in whispers—the Lockheed 1011 LANIMAR WARES Inviscid wake-airfoil interaction on mulhiqh lift systems LAND USE An innovative approach to airport planni LANDING AIDS The simulation and analysis of carrier 1 using a nonlinear pilot model [AD-767679] Microwave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n MLS development program. Part 1.0, vo Technique analysis program [FAL-RD-73-166-vol1.1] Hicrowave Landing System (MLS) development program.	a74-18808 A74-18808 A74-13737 A74-17532 Certifying A74-17856 tielement A74-18193 A74-18099 andings B74-13747 nt plan as nalysis ational lume 1.1: B74-1434C ent plan as
Research on noise generated by ducted air- combustion systems [AD-767337] Plight velocity effects on jet noise of sy variations of a twelve-chute suppressor installed on a plug nozzle [MASA-TB-I-2918] Combustion generated noise in turbopropula systems [AD-768615] JET ENGINE FUELS The refining of turbine fuels by modern hydrotreating [AIAA PAPER 74-162] Supersonic fuels from medium oils produce thermal cracking of crude oil residues [DFYLR-SONDDR-301] Optimal capabilities of hypersonic passen aircraft on kerosene fuel [AD-767887] Problems of chemical pollution by aircraf airport and its immediate environment Ground contamination by fuel jettisoned f aircraft Effect of increased fuel temperature on e of oxides of pitrogen from a gas turbin combustor hurning ASTM jet-A fuel [BASA-TH-I-2931] JET ERGINES Hon-destructive inspection of titanium je disks The problem of installing a modern high h engine on a twin jet transport aircraft	#74-13730 -fuel #74-14445 everal #74-15466 sion #74-15666 #74-18798 #74-18925 ger #74-13737 t. The #74-14281 rom #74-14283 missions #874-15659 et engine #74-16480 ettpass #74-14727 firintakes #74-14727 firintakes #74-14727 firintakes	EXALMAN FILTERS A self-reorganizing digital flight control for aircraft [AIAA PAPER 74-21] ERROSSEE Optimal capabilities of hypersonic passes aircraft on kerosene fuel [AD-767887] L-1011 AIRCRAFT L-1011 upkeep [SAE PAPER 730883] New jumbo lets must speak in whispers — the Lockheed 1011 LAMINAR WARES Inviscid wake-airfoil interaction on mulhigh lift systems LAND USE An innovative approach to airport planni LANDING AIDS The simulation and analysis of carrier 1 using a nonlinear pilot model [AD-767679] Microwave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n MLS development program [FAA-RD-73-166-VOL-1.1] Hicrowave Landing System (MLS) development proposed by AIL during the technique and System (FALS) development program [FAA-RD-73-166-VOL-1.1] Hicrowave Landing System (MLS) development proposed by AIL during the technique and proposed by AIL during the technique	a74-18808 nqer
Research on noise generated by ducted air- combustion systems [AD-767337] Plight velocity effects on jet noise of systems [AD-767337] Plight velocity effects on jet noise of systems [MESA-TH-I-2918] Combustions of a twelve-chute suppressor installed on a plug nozzle [MESA-TH-I-2918] Combustion generated noise in turbopropula systems [AD-768615] JET EMGIME FURLS The refining of turbine fuels by modern hydrotreating [AIAA PAPER 74-162] Supersonic fuels from medium oils produce thermal cracking of crude oil residues [DFYLR-SONDDR-301] Optimal capabilities of hypersonic passen aircraft on kerosene fuel [AD-767887] Problems of chemical pollution by aircraf airport and its immediate environment Ground contamination by fuel jettisoned f aircraft Effect of increased fuel temperature on e of oxides of nitrogen from a gas turbin combustor burning ASTM jet-A fuel [MESA-TH-I-2931] JET EMGIMES Bon-destructive inspection of titanium jed disks The problem of installing a modern high h engine on a twin jet transport aircraft Aerodynamic aspects of the problems of air and exhaust for a supersonic transport —— design of air intake and after body	#74-13730 -fuel #74-14445 everal #74-15466 sion #74-15666 A74-18798 d by the A74-18925 ger #74-13737 t. The #74-14281 row #74-14283 missions e #74-15659 et engine A74-16480 everal #74-14727 fir-intakes aircraft for fiet	EXALHAN FILTERS A self-reorganizing digital flight control for aircraft [AIAA PAPER 74-21] EEROSENE Optimal capabilities of hypersonic passes aircraft on kerosene fuel [AD-767887] L-1011 AIRCRAFT L-1011 upkeep [SAE PAPER 730883] New jumbo jets must speak in whispers the Lockheed 1011 LAMINAR WAKES Inviscid wake-airfoil interaction on mulhigh lift systems LAND USE An innovative approach to airport planni LANDING AIDS The simulation and analysis of carrier 1 using a nonlinear pilot model [AD-767679] Microwave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n MLS development program. Part 1.0, vo Technique analysis program [FAL-RD-73-166-Vol-1.1] Bicrowave Landing System (MLS) development proposed by AIL during the technique and contract definition phase of the n contract definition phase of the normal contract definition phase of the many contract definition phase of the normal contract defin	arystem Ary
Research on noise generated by ducted air- combustion systems [AD-767337] Plight velocity effects on jet noise of sy variations of a twelve-chute suppressor installed on a plug nozzle [MASA-TB-I-2918] Combustion generated noise in turbopropula systems [AD-768615] JET ENGINE FUELS The refining of turbine fuels by modern hydrotreating [AIAA PAPER 74-162] Supersonic fuels from medium oils produce thermal cracking of crude oil residues [DFYLR-SONDDR-301] Optimal capabilities of hypersonic passen aircraft on kerosene fuel [AD-767887] Problems of chemical pollution by aircraf airport and its immediate environment Ground contamination by fuel jettisoned f aircraft Effect of increased fuel temperature on e of oxides of pitrogen from a gas turbin combustor hurning ASTM jet-A fuel [BASA-TH-I-2931] JET ERGINES Hon-destructive inspection of titanium je disks The problem of installing a modern high h engine on a twin jet transport aircraft	#74-13730 -fuel #74-14445 everal #74-15466 sion #74-15666 #74-18798 #74-18925 ger #74-13737 t. The #74-14281 rom #74-14283 missions #874-15659 et engine #74-16480 ettpass #74-14727 firintakes #74-14727 firintakes #74-14727 firintakes	EXALMAN FILTERS A self-reorganizing digital flight control for aircraft [AIAA PAPER 74-21] ERROSENE Optimal capabilities of hypersonic passes aircraft on kerosene fuel [AD-767887] L-1011 AIRCRAFT L-1011 upkeep [SAE PAPER 730883] New jumbo jets must speak in whispers—the Lockheed 1011 LAMINAR WARES Inviscid wake-airfoil interaction on mulhiqh lift systems LAND USE An innovative approach to airport planni LAWDING AIDS The simulation and analysis of carrier 1 using a nonlinear pilot model [AD-767679] Microwave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n HLS development program. Part 1.0, vo Technique analysis program [FAL-RD-73-166-vol-1.1] Bicrowave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n HLS development program. Part 1.0, vo	arystem Ary
Research on noise generated by ducted air- combustion systems [AD-767337] Plight velocity effects on jet noise of systems [AD-767337] Plight velocity effects on jet noise of systems [MESA-TH-X-2918] Combustions of a twelve-chute suppressor installed on a plug nozzle [MESA-TH-X-2918] Combustion generated noise in turbopropula systems [AD-768615] JET ENGINE FUBLS The refining of turbine fuels by modern hydrotreating [AIAN PAPER 74-162] Supersonic fuels from medium oils produce thermal cracking of crude oil residues [DFYLE-SONDE-301] Optimal capabilities of hypersonic passen aircraft on kerosene fuel [AD-767887] Problems of chemical pollution by aircraf airport and its immediate environment Ground contamination by fuel jettisoned f aircraft Effect of increased fuel temperature on e of oxides of bitrogen from a gas turbin combustor hurning ASTM jet-A fuel [HASA-TH-I-2931] JET ENGINES Bon-destructive inspection of titanium je disks The problem of installing a modern high h engine on a twin jet transport aircraft Aerodynamic aspects of the problems of ai and exhaust for a supersonic transport design of air intake and after body engine for Concorde aircraft	#74-13730 -fuel #74-14445 everal #74-15466 sion #74-15666 A74-18798 d by the A74-18925 ger #74-13737 t. The #74-14281 row #74-14283 missions e #74-15659 et engine A74-16480 everal #74-14727 fir-intakes aircraft for fiet	EXALHAN FILTERS A self-reorganizing digital flight control for aircraft [AIAA PAPER 74-21] EEROSENE Optimal capabilities of hypersonic passes aircraft on kerosene fuel [AD-767887] L-1011 AIRCRAFT L-1011 upkeep [SAE PAPER 730883] New jumbo jets must speak in whispers the Lockheed 1011 LAMINAR WAKES Inviscid wake-airfoil interaction on mulhigh lift systems LAND USE An innovative approach to airport planni LANDING AIDS The simulation and analysis of carrier 1 using a nonlinear pilot model [AD-767679] Microwave Landing System (MLS) developme proposed by AIL during the technique a and contract definition phase of the n MLS development program. Part 1.0, vo Technique analysis program [FAL-RD-73-166-Vol-1.1] Bicrowave Landing System (MLS) development proposed by AIL during the technique and contract definition phase of the n contract definition phase of the normal contract definition phase of the many contract definition phase of the normal contract defin	arystem Ary

Microwave Landing System (MLS) development plan as	LIFT DEVICES
proposed by AIL during the technique analysis	On the modes of icing of symmetrical lifting
and contract definition phase of the national MLS development program. Part 3.0, Volume 3.1,	surfaces
Book 1: Compilation of critical technical area	174-1898
reports	blown flap. Volume 3: Performance methods and
(FAA-RD-73-166-VOL-3.1,1-BK-1] H74-14343	landing rules
Microwave Landing System (MLS) development plan as	[AD-767180] N74-13759
proposed by AIL during the technique analysis and contract definition phase of the national	LIFT DRAG HATIO
MLS development program. Part 3.0, Volume 3.1,	Trimmed drag and maximum flight efficiency of aft tail and canard configurations
Book 2: Compilation of critical technical area	{Alaa Paper 74-69] A74-1881:
reports	LIFT FARS
[PAN-RD-73-166-VOL-3, 1, 2-BK-2] H74-14344	Q-FANSTM for general aviation aircraft
User's manual for ILSLOC: Simulation for	[NASA-CR-114665] N74-13726
derogation effects on the localizer portion of the instrument landing system	LIPTING BODIES
[AD-768049] X74-14361	Relaxation methods for transonic flow about
Simplified Visual Approach Slope Indicator (VASI)	wing-cylinder combinations and lifting swept wings
Operation test and evaluation	A74-1695 Lifting-surface theory for an oscillating T-tail
[AD-767901] N74-14362	A74-17012
LANDING GRAR	Nonlinear airfoil theory with allowance for ground
STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study	effects for aerodynamic interference
[AD-767300] N74-13736	problems solution
Graphite composite landing gear components - side	174-17270 On the modes of icing of symmetrical lifting
brace assembly and torque link for A37 B aircraft	surfaces
[AD-769041] H74-14779	a74-16987
LANDING LOADS	Flutter computer program and lifting surface
An analytic approximate calculation of the nonlinear landing impact motions and loads on	theory with boundary layer
aircraft with both rigid and elastic wing	[NASA-CR-136559] H74-14707
structure	Drag of lifting bodies for pilots at high altitude
[DGLR PAPER 73-078] A74-17185	LIFTING BOTORS N74-14731
LAP_JOINTS	Concepts for a theoretical and experimental study
Evaluation of methods for reducing fretting	of lifting rotor random loads and vibrations,
fatique damage in 2024-T3 aluminum lap joints	Phase 1
LASER PANGER/TRACKER	[NASA-CR-114707] N74-14755
Lasers - Ranger and marked target seeker	Concepts for a theoretical and experimental study
A74-16756	of lifting rotor random loads and wibrations (identification of lifting rotor system
LATERAL STABILITY	parameters from transient response data), Phase
Rulti-surface system for the CCV B-52 Control	7-B
Configured Vehicles	[NA SA-CR-114710] N74-14758
(AIAA PAPER 74-1261 A74-18851 LAW (JURISPRUDENCE)	Concepts for a theoretical and experimental study
The German law for protection against the noise of	OI lilting rotor random loads and wibrations
aircraft	(further experiments with progressing/regressing
a74-18265	rotor flapping modes), Phase 7-C [NASA-CR-114711] N74-12759
LEADING EDGES	LIGHT AIRCRAPT N74-14759
Numerical investigation of vortex sheets issuing	Vehicle crashworthiness rotary wing, fixed
from a separation line near the leading edge	wing light and transport aircraft
LEGAL LIABILITY	174-17776
Vortex cases - At a turbulent crossroads	Structural analysis of light aircraft using NASTRAN
aircraft wakes and legal liability for accidents	[AIAA PAPER 74-257] A74-18664 LIGHTWING
170-18097	Analysis and calculation of lightning-induced
Government responsibility for damages in airplane	voltages in aircraft electrical circuits
crash cases when weather is a factor	[NASA-CR-2349] N74-14754
A74-18098 The aftermath of a hijacking - Passenger claims	LOAD DISTRIBUTION (FORCES)
and insurance	Calculation of the induced velocity field on and
¥74-18101	off the wing plane for a swept wing with given load distribution
LIFT	[ARC-R/M-3725] #74-14766
A method of designing supercritical lift profiles	LONGITUDINAL STABILITY
[DGLR PAPER 73-081] Unsteady lift forces on highly cambered airfoils	Automatic balancing of an aircraft
moving through a gust	A74-17804
[AIAA PAPER 74-88] A79-18807	LOW ALTITUDE
LIFT AUGHENTATION	Calculation of the aerodynamic characteristics of
STOL tactical aircraft investigation, externally	a wing system moving at subsonic speed near land or smooth water surface
DIDEN IIAP. VOLUME 1: Configuration	A74-18681
definition. Supplement 1: Aerodynamic trades of flap and roll control system	LOW ASPECT RATIO BINGS
[AD-767179] wan-12750	A method of calculating the flow around a wing of
STOL tactical aircraft investigation externally	arpitrary planform, positioned on a cylindrical
provi tiap, volume 3: Performance methods and	body
ranging rules	LOW SPEED WIND TORNELS A74-18632
[AD-767180] N74-13755	Modeling a bigh pressure ratio centrifugal
STOL tactical aircraft investigation, externally	Compressor using a low speed of sound das
blown flap. Volume 5, part 1: Control system mechanization trade studies	[AD-767241] N74-16446
[AD-767181] . NZA-42354	LOBRICANTS
STOL tactical aircraft investigation externally	Aviation fuels and lubricants
Production Antilos of Dark in Graphilite and	A74-18180
CONTROL GEFLYATIVE ACCUPACY FACULT SHAPE SAA	
the cost of augmentation system design	
N74-13757	

	M	
HACH BURBER A direct method for Mach number one pa	computing the st	eady flow at
Problem of adapting		A74-16963
for extremely high		
HAGNUS BPPECT Hagnus characteristi [AGARD-AG-171]	cs of arbitrary	rotating bodies N74-13710
NAINTAINABILITY Avionics design for	maintainability .	
qaining or losing [SAE PAPER 730882]	J ·	A74-17531
I-1011 upkeep SAB PAPER 730883 HAN MACHINE SYSTEMS	I	A74-17532
The impact of area r	avigation on flic	_
Innovations in ATC of	communication sys	174-17277 tems since
NABAGEMENT PLANNING		174-17984
Development of requi	idvanced design a:	ircraft
[SAE PAPER 730948] Aircraft force prote quide to AFPR	ction model. Vo.	A74-17541 lume 1: Users to determine
aircraft inventors	and operating r	eguirements N74-13751
Nonlinear aerodynam: high-angle-of-atta		n
(ALLA PAPER 74-85)		174-1876 5
Manufacturing exercitive Hawker Siddele	ise involved in t by Trident /tri-j	he redesign of et/ fuselage 274-16445
MARINE PROPULSION Turning characterist	ics of the Bell	
surface effect sh: [AD-767680]		N74-13753
MARINE TECHNOLOGY Turning characterist		100 ton
surface effect shi [AD-767680] NARKET RESEARCH		¥74-13753
Development of required of manufacturer	idvanced design a	ircraft
(SAE PAPER 730948 MASS TRANSFER Ablation heat a	_	A74-17541 in hypersonic
flight		A74-17103
Refrigerated contain	merized transport	for 'Jumbo'
jets Pailure analysis of	helicopter exter	A74-17007
cargo-handling sy: (AD-767254)		N74-13729
MATERIALS SCIEFCE Materials for the no	ew generation of	aircraft 174-17374
MATERIALS TESTS Ultrasonic inspecti	on of titanium ai	-
components		A74-16479
A vortex entrainment delta wings	t model applied t	
Stratosphere contan	ination by aircra	374-17029 ft and
An unsteady wake mo		174-17312 ss rotor
Structural analysis	of light aircraf	A74-18140 t using WASTRAN A74-18664
Jet noise modeling for the noise and	- Experimental st turbulence field	udy and models
[AIAA PAPER 74-3] Two numerical metho	ds to solve reali	A74-18723 stic
air-to-air combat [AIAA PAPER 74-22]	es 174-18736

MECHANICAL DRIVES	-4+
Transmission thermal mapping (CH-47C forwa	ita totor
transmission) [AD-767875]	N79-13732
NECHANICAL ENGINEERING	
neutsche Forschungs- und Versuchsanstalt f	uer
Luft- und Raumfahrt, Annual Report 1972	
German book	A74-17969
HECHANICAL PROPERTIES	A 74-17303
Flat rolled beta titanium alloys for airfr	ane
application	
	174-16449
Applications of the high strength alloy	
Ti-481-480-25n-0.55i in European aircraf	274-16450
Deep hardenable titanium alloys for large	
elements	
	A74-16559
Status of the latest turbine disk alloys i	n the US
	174-17890
Reat-resistant titanium alloys - Introduct the 651 A alloy	.104 01
the col E alloh	A74-17891
METAL COMBUSTION	
Pailure experience with and failure antici	pation
in titanium components	
	A74-16476
HETAL CUTTING Titanium flamecutting reduces airframe cos	:ts
TITABLE ILAMECACCING FEAGUES SILLIAME COL	A74-16760
METAL FATIGUE	
Failure experience with and failure antici	pation
in titanium components	A74-16476
High cycle fatigue properties of titanium	
aircraft application	***
WILLIAM SPRINGS	A74-16513
METAL FILES	
I film thermocouple with a platinum electr	ode for
thermometry of que turbine engine blades	3 174-18686
RETAL HYDRIDES	E74-10000
Nondestructive detection of hydrides and	
Nondestructive detection of hydrides and alpha-case in titanium alloys	
Nondestructive detection of hydrides and alpha-case in titanium alloys	A74-16482
Nondestructive detection of hydrides and alpha-case in titanium alloys METAL NATRIX COMPOSITES	
Nondestructive detection of hydrides and alpha-case in titanium alloys METAL NATRIX COMPOSITES Titanium - The bridge to composites for	
Nondestructive detection of hydrides and alpha-case in titanium alloys METAL NATRIX COMPOSITES	
Nondestructive detection of hydrides and alpha-case in titanium alloys METAL NATRIX COMPOSITES Titanium - The bridge to composites for	or light 174-16451 stronautics
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL NATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as	a74-16451
Nondestructive detection of hydrides and alpha-case in titanium alloys METAL MATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS	or light A74-16451 stronautics A74-18190
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of meronautics and as METAL STRIPS Plat rolled beta titanium alloys for airfi	or light A74-16451 stronautics A74-18190
Nondestructive detection of hydrides and alpha-case in titanium alloys METAL MATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS	a74-16451 stronautics a74-18190
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of meronautics and as METAL STRIPS Plat rolled beta titanium alloys for airfi	or light A74-16451 stronautics A74-18190
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Plat rolled beta titanium alloys for airfrapplication METAL MORKING Deep hardenable titanium alloys for large	274-16451 stronautics 274-18190 came 274-16449
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of meronautics and as METAL STRIPS Plat rolled beta titanium alloys for airfrapplication METAL MORKING	A74-16451 stronautics A74-18190 came A74-16449 airframe
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL MATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of meronautics and as METAL STRIPS Plat rolled beta titanium alloys for airfrapplication METAL WORKING Deep hardenable titanium alloys for large elements	274-16451 stronautics 274-18190 came 274-16449
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfrapplication METAL WORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT	A74-16451 stronautics A74-18190 came A74-16449 airframe
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL MATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of meronautics and as METAL STRIPS Plat rolled beta titanium alloys for airfrapplication METAL WORKING Deep hardenable titanium alloys for large elements	A74-16451 stronautics A74-18190 came A74-16449 airframe
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfrapplication METAL WORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT The Eole balloons and air safety HETEOROLOGICAL PARAMETERS	A74-16451 stronautics A74-18190 came A74-16449 airframe A74-16559
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfr application METAL BORKING Deep hardenable titanium alloys for large elements METROROLOGICAL FLIGHT The Bole balloons and air safety METROROLOGICAL PARAMETERS Dynamic test of air data computers with si	A74-16451 stronautics A74-18190 came A74-16449 airframe A74-16559
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfrapplication METAL WORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT The Eole balloons and air safety HETEOROLOGICAL PARAMETERS	274-16451 274-16451 274-18190 288e 274-16499 274-16559 274-16559 274-18596
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assemble to a second to a secon	A74-16451 stronautics A74-18190 came A74-16449 airframe A74-16559
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL MATRIX COMPOSITES Titanius - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Plat rolled beta titanium alloys for airformapplication METAL MORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT The Eole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with significant profiles METEOROLOGICAL SERVICES Government responsibility for damages in a	A74-16451 stronautics A74-18190 came A74-16449 airframe A74-16559 A74-18596 isolated
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanius - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfr application METAL MORRING Deep hardenable titanium alloys for large elements METROROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with siflight profiles METEOROLOGICAL SERVICES	A74-16451 stronautics A74-18190 came A74-16449 airframe A74-16559 A74-18596 imulated A74-17736
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfr application METAL MORKING Deep hardenable titanium alloys for large elements METEOROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with siflight profiles METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor	A74-16451 stronautics A74-18190 came A74-16449 airframe A74-16559 A74-18596 isolated
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanius - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assumetal strips Plat rolled beta titanium alloys for airfrapplication METAL MORRING Deep hardenable titanium alloys for large elements METEOROLOGICAL FLIGHT The Eole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with siflight profiles METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor	A74-16451 stronautics A74-18190 came A74-16499 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18698
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assume that the structural materials alloys for airfurctural materials and air safety HETEOROLOGICAL FLIGHT The Eole balloons and air safety HETEOROLOGICAL PARAMETERS Dynamic test of air data computers with significant for a factor METEOROLOGICAL SERVICES Government responsibility for damages in a crash cases when weather is a factor MICROWAVE EQUIPMENT Bicrowave Landing System (MLS) development	A74-16451 stronautics A74-18190 same A74-16449 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assume that the structural materials and air safety METAL MORRING Deep hardenable titanium alloys for large elements METROROLOGICAL FLIGHT The Bole balloons and air safety METROROLOGICAL PARAMETERS Dynamic test of air data computers with significant test of air data computers with significant cases when weather is a factor MICROWAYE RQUIPMENT Bicrowaye Landing System (MLS) development proposed by AIL during the technique and	a74-16451 stronautics a74-18190 came a74-16499 airframe A74-16559 a74-18596 ibulated a74-17736 airplane a74-18098 t plan as
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanius - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assume that the structural materials alloys for airfurctural materials and air safety METEOROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with significant test of	a74-16451 stronautics a74-18190 came a74-16499 airframe A74-16559 a74-18596 ibulated a74-17736 airplane a74-18098 t plan as
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as METAL STRIPS Flat rolled beta titanium alloys for airfr application METAL BORKING Deep hardenable titanium alloys for large elements METROROLOGICAL FLIGHT The Bole balloons and air safety METROROLOGICAL PARAMETERS Dynamic test of air data computers with siflight profiles METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor MICROWAN ROUIPMENT Microwave Landing System (MLS) development proposed by ALL during the technique and and contract definition phase of the nather technique analysis program	A74-16451 stronautics A74-18190 came A74-16499 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as alysis tional ume 1.1:
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanius - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assembly and administration are application METAL STRIPS Plat rolled beta titanium alloys for airformatication METAL WORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with siflight profiles METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor MICROWAVE RQUIPMENT Microwave Landing System (MLS) development proposed by AIL during the technique and and contract definition phase of the nate and contract definition phase of the nate and contract definition phase of the nate and contract definition phase of the parameter of	A74-16451 stronautics A74-18190 same A74-16449 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as alysis tional ume 1.1: A74-14340
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanius - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assembly and administration are application METAL STRIPS Plat rolled beta titanium alloys for airformatication METAL WORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with siflight profiles METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor MICROWAVE RQUIPMENT Microwave Landing System (MLS) development proposed by AIL during the technique and and contract definition phase of the nate and contract definition phase of the nate and contract definition phase of the nate and contract definition phase of the parameter of	A74-16451 stronautics A74-18190 same A74-16449 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as alysis tional ume 1.1: A74-14340
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as the structural materials and air safety METEOROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with significant structural structural safetor METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor MICROWAYE RQUIPMENT Microwave Landing System (MLS) development proposed by AIL during the technique and ITAL materials program [FAA-RD-73-166-VOL-1.1] Microwave Landing System (MLS) development proposed by AIL during the technique and and contract definition phase of the name and contract definition phase of the second se	A74-16451 stronautics A74-18190 same A74-16449 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as alysis tional ume 1.1: A74-14340 t plan as alysis tional
Wondestructive detection of hydrides and alpha-case in titanium alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and as the structural materials and air safety METEOROLOGICAL FLIGHT The Bole balloons and air safety METEOROLOGICAL PARAMETERS Dynamic test of air data computers with significant structural structural safetor METEOROLOGICAL SERVICES Government responsibility for damages in crash cases when weather is a factor MICROWAYE RQUIPMENT Microwave Landing System (MLS) development proposed by AIL during the technique and ITAL materials program [FAA-RD-73-166-VOL-1.1] Microwave Landing System (MLS) development proposed by AIL during the technique and and contract definition phase of the name and contract definition phase of the second se	A74-16451 stronautics A74-18190 same A74-16449 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as alysis tional ume 1.1: A74-14340 t plan as alysis tional
Wondestructive detection of hydrides and alpha-case in titanius alloys METAL HATRIX COMPOSITES Titanium - The bridge to composites for weight/high performance aircraft Structural materials of aeronautics and assume that the strips of aeronautics are alloys for airful application. HETAL BORKING Deep hardenable titanium alloys for large elements HETEOROLOGICAL FLIGHT The Bole balloons and air safety HETEOROLOGICAL PARAMETERS Dynamic test of air data computers with significant test of air data computers	A74-16451 stronautics A74-18190 same A74-16449 airframe A74-16559 A74-18596 imulated A74-17736 airplane A74-18098 t plan as alysis tional ume 1.1: A74-14340 t plan as alysis tional

A74-18736

Microwave Landing System (MLS) development plan as	Mircraft force protection model. Volume 1: Users
proposed by AIL during the technique analysis	quide to AFPN computer program to determine
and contract definition phase of the national	aircraft inventory and operating requirements
ML5 development program, Part 1.0, Volume 1.2,	[AD-767946] X74-1375
Book 2: Post TACD development plan	Hilitary aircraft and airport noise and
FPAR-RD-73-166-YOL-1.2,2-BK-2 N74-14342 Hicrowave Landing System (HLS) development plan as	opportunities for reduction without inhibition
proposed by AIL during the technique analysis	of military missions [PB-223637/DGA] N74-1375
and contract definition phase of the national	STOL tactical aircraft investigation, externally
MLS development program. Part 3.0, Volume 3.1,	blown flap. Volume 1: Configuration
Book 1: Compilation of critical technical area	definition, Supplement 1: Aerodynamic trades of
reports	flap and roll control system
[FAA-RD-73-166-VOL-3.1,1-BK-1] N74-14343	[AD-767179] N74-1375
Microwave Landing System (MLS) development plan as proposed by AIL during the technique analysis	STOL tactical aircraft investigation, externally
and contract definition phase of the national	blown flap. Volume 3: Performance methods and landing rules
MLS development program. Part 3.C, Volume 3.1,	[AD-767180] N74-1375
Book 2: Compilation of critical technical area	STOL tactical aircraft investigation, externally
reports	blown flap. Volume 5, part 1: Control system
[PAA-RD-73-166-VOL-3.1,2-BK-2] N74-14344	mechanization trade studies
MICROWAVE PREQUENCIES	[AD-767181] N74-1375
Microwave Landing System (MLS) development plan as proposed by Raytheon during the technique	STOL tactical aircraft investigation, externally
analysis and contract definition phase of the	blown flap, Volume 5, part 3: Stability and control derivative accuracy requirements and
national BLS development program, Volume 1:	effects of augmentation system design
Executive summary	[AD-767182] N74-1375
[PAA-RD-73-150-1] N74-15381	Development of techniques to measure in-flight
Microwave Landing System (MLS) development plan as	drag of a US Navy fighter airplane and
proposed by Haytheon during the technique	correlation of flight measured drag with wind
analysis and contact definition phase of the national MLS development program. Volume 3:	tunnel data
1.1.1 performance validation	BILITARY HELICOPTERS N74-1473
[PAA-RD-73-150-3] N74-15382	The T700-GE-700 turboshaft engine program
Microwave Landing System (MLS) development plan as	[SAE-PAPER 730917] A74-1753
proposed by Raytheon during the technical	Rotary-wing aircraft
analysis and contract definition phase of the	174-1817
national MLS development program, Volume 3A (FAA-RD-73-150-3A) 974-15383	Automatic Flight Control System development for
Microvave Landing System (MLS) development plan as	U.S. Army beavy lift helicopter [AIAA PAPER 74-25] A74-1886
proposed by Raytheon during the technique	T700 aims at low combat maintenance turboshaft
analysis and contract definition phase of the	engine for military transports and helicopters
hational MLS development program. Volume 4:	A74-1899
System considerations 1,1.2 through 1.1.5	US Army helicopter hydraulic servocylinder
[PAA-RD-73-150-4] N74-15384 Microwave Landing System (MLS) development plan as	reliability and maintainability investigation
proposed by Raytheon during the technique	[AD-767243] N74-1373
analysis and contract definition phase of the	Bethods for reducing vibrations of equipment mounted on helicopter external stores stations
pational MLS development program. Volume 5:	damping of vertical vibrations of
Post TA/CD plans, management performance	wing-mounted stores on AH-1G helicopter
[FAR-RD-73-150-5] N74-15385	[AD-768774] H74-1477
Microwave Landing System (MLS) development plan as	In-flight stabilization of externally slung
proposed by Raytheon during the technique analysis and contract definition phase of the	helicopter loads design, development, and
national MLS development program. Volume 6:	evaluation of candidate stabilizing systems [AD-769063] N74-1477
Supporting studies, appendices D through N	Major Item Special Study (MISS), AH-1G driveshaft
(FAA-RD-73-150-6-APP-D-N) N74-15386	assembly, main transmission to engine
HIDAIR COLLISIONS	[AD-768763] N74-14780
The Eole balloons and air safety	
	HILITARY TECHNOLOGY
174-18596	HILITARY TECHNOLOGY The S-3A - A new dimension in airborne sea control
BILITARY AIRCRAPT	MILITARY TECHNOLOGY The S-3A - A new dimension in airborne sea control [AIAA PAPER 74-239] A74-1920
A74-18596 SILITABY AIRCRAPT The use of ultra high strength titanium alloys in	MILITARY TROUBOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} A74-1920
BILITARY AIRCRAPT	MILITARY TRUENOLOGY The S-3A - A new dimension in airborne sea control [AIAA PAPER 74-239] A74-19209 MISSIE DESIGN Comparative study of various flight vehicle
A74-18596 BILITABY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier A74-16446	MILITARY TROUBOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} A74-1920
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier A74-16446 Noise and emission outlook for military engines	MILITARY TROUBOLOGY The S-3A - A new dimension in airborne sea control (AIAA PAPER 74-239) A74-19209 BISSIEM DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-668] A74-1717
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier A74-16446 Noise and emission outlook for military engines (AIAA PAPER 73-1156) A74-17175	MILITARY TRCHROLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight wehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-069] A74-1717 BORRETUR TERORY
BILITABY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft	MILITARY TROUDORY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239] A74-1920! BISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 BONERIUM THEORY An unsteady wake model for a hingeless rotor
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier A74-16446 Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft A74-18176	MILITIBY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} A74-19205 BISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 BORRETUR THEORY An unsteady wake model for a hingeless rotor A74-18146
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] The new Advanced Airborne Command Post [AIAA PAPER 74-246] A74-18654	MILITARY TRCHROLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-068] A74-1717 MONESTUR THEORY An unsteady wake model for a hingeless rotor HOWLITORS
BILITARY AIRCRAFT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-17175 Fixed wing aircraft The new Advanced Airborne Command Post	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239] A74-1920! BISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 BONEMETUR THEORY An unsteady wake model for a hingeless rotor BONITORS Flight study of a vehicle operational status and
BILITARY AIRCRAFT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] The Alpha Jet programme A74-18902	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 MONESTUR THEORY An unsteady wake model for a hingeless rotor M74-1814(BONITORS Flight study of a vehicle operational status and monitoring system applied to systems on IF-12 aircraft
BILITABY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H, S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] The new Advanced Airborne Command Post [AIAA PAPER 74-24C] The Alpha Jet programme A74-18902 STOL tactical aircraft investigation. Volume 2:	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239] MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 MOMBRITUE THEORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on YF-12 aircraft [NASA-TN-D-7546] R74-13725
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-24C] The Alpha Jet programme A74-1854 STOL tactical aircraft investigation. Volume 2: Design compendium	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 MOMBETUR THRORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on IF-12 aircraft [NASA-TN-D-7546] MOVING TARGET INDICATORS
BILITABY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] The Alpha Jet programme A74-18902 STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561]	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLE PAPER 73-068] A74-1717 MOMBETUR TREORY An unsteady wake model for a hingeless rotor HOWITORS Flight study of a vehicle operational status and monitoring system applied to systems on IF-12 aircraft [NASA-TN-D-7546] MOVING TARGET INDICATORS New concepts in AMTI radar - Hulling effects of
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-24C] The Alpha Jet programme A74-1854 STOL tactical aircraft investigation. Volume 2: Design compendium	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-668] A74-1717 MOMBRYTHE TREORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on IP-12 aircraft [NASA-TH-D-7546] MOVING TARGET INDICATORS New concepts in AMII radar - Hulling effects of Doppler filter/multi-element horn array
BILITABY AIRCRAFT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] The Alpha Jet programme STOL tactical aircraft investigation. [AP-767561] STOL tactical aircraft investigation. Wind tunnel data analysis [AD-767363]	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] M74-1717 MOMBRITUM THEORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on YF-12 aircraft [NASA-TN-D-7546] MOVING TARGET INDICATORS New concepts in ANTI radar - Nulling effects of Doppler filter/multi-element horn array A74-1725
### The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier **Noise and emission outlook for military engines [AIAA PAPER 73-1156]	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-668] A74-1717 MOMBRYTHE TREORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on IP-12 aircraft [NASA-TH-D-7546] MOVING TARGET INDICATORS New concepts in AMII radar - Hulling effects of Doppler filter/multi-element horn array
The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] The Alpha Jet programme STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 4: Flight control technology	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] M74-1717 MOMENTUME THEORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on IF-12 aircraft [NASA-TH-D-7546] MOVING TARGET INDICATORS New concepts in AMII radar - Hulling effects of Doppler filter/multi-element horn array A74-17252
BILITABY AIRCRAFT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] The Alpha Jet programme A74-18902 STOL tactical aircraft investigation. Design compendium [AD-767561] STOL tactical aircraft investigation. Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Plight control technology [AD-767364] H74-13735	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example {DGLR PAPER 73-068} A74-1717 MOMBETUR TREORY An unsteady wake model for a hingeless rotor HOWITORS Flight study of a vehicle operational status and monitoring system applied to systems on IP-12 aircraft [MASA-TN-0-7546] MOVING TARGET INDICATORS New concepts in AMTI radar - Hulling effects of Doppler filter/multi-element horn array A74-17252 N MASA PROGRAMS
BILITABY AIRCRAFT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] The new Advanced Airborne Command Post [AIAA PAPER 74-24C] The Alpha Jet programme STOL tactical aircraft investigation. [AD-767561] STOL tactical aircraft investigation. Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Flight control technology [AD-767364] Flight control technology [AD-767364] FOL tactical aircraft investigation. FOUNDE 5: Flight control technology [AD-767364] FOL tactical aircraft investigation. FOUNDE 6:	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] A74-1717 MOMBRYTON TROOMY An unsteady wake model for a hingeless rotor A74-1814(MOMBITORS Flight study of a vehicle operational status and monitoring system applied to systems on IP-12 aircraft [NASA-TH-D-7546] MOVING TARGET INDICATORS New concepts in AMTI radar - Hulling effects of Doppler filter/multi-element horn array A74-17252 N MASA PROGRAMS Putting all our noise technology to work MASA Putting all our noise technology to work MASA
The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-16446 Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-17175 Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] A74-18654 The Alpha Jet programme STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Flight control technology [AD-767364] STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-068] M74-1717 MOMBETUR THEORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on IF-12 aircraft [NASA-TH-D-7546] MOVING TARGET INDICATORS New concepts in AMII radar - Nulling effects of Doppler filter/multi-element horn array A74-1725 N MASA PROGRAMS Putting all our noise technology to work MASA Quiet Engine Program
The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-16446 Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-17175 Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] A74-18654 The Alpha Jet programme STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] N74-13734 STOL tactical aircraft investigation. Volume 5: Flight control technology [AD-767364] R74-13735 STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] R74-13736 Orientation-error accidents in regular Arw GH-1	MILITARY TRCHNOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239] MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example {DGLR PAPER 73-068} A74-1717 MOMBITUR TREORY An unsteady wake model for a hingeless rotor HOWITORS Flight study of a vehicle operational status and monitoring system applied to systems on IP-12 aircraft [NASA-TN-D-7546] MOVING TARGET INDICATORS New concepts in AMTI radar - Hulling effects of Doppler filter/multi-element horn array A74-17252 N MASA PROGRAMS Puting all our noise technology to work MASA Quiet Engine Program A74-17045
BILITARY AIRCRAPT The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier A74-16446 Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-17175 Fixed wing aircraft A74-18176 The new Advanced Airborne Command Post [AIAA PAPER 74-240] The Alpha Jet programme A74-18654 The Alpha Jet programme STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] Orientation-error accidents in regular Army GH-1 aircraft during fiscal year 1970: Relative	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example [DGLR PAPER 73-668] A74-1717 MOMENTUM TREORY An unsteady wake model for a hingeless rotor A74-18146 MOBITORS Flight study of a vehicle operational status and monitoring system applied to systems on YF-12 aircraft [NASA-TH-D-7546] MOVING TARGET INDICATORS New concepts in AMTI radar - Hulling effects of Doppler filter/multi-element horn array A74-17252 N MASA PROGRAMS Putting all our noise technology to work MASA Quiet Engine Program Hilitary and aerospace cost effective
The use of ultra high strength titanium alloys in a V/STOL military aircraft application - The H. S. A. Harrier Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-16446 Noise and emission outlook for military engines [AIAA PAPER 73-1156] A74-17175 Fixed wing aircraft The new Advanced Airborne Command Post [AIAA PAPER 74-240] A74-18654 The Alpha Jet programme STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] N74-13734 STOL tactical aircraft investigation. Volume 5: Flight control technology [AD-767364] R74-13735 STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] R74-13736 Orientation-error accidents in regular Arw GH-1	MILITARY TRCHMOLOGY The S-3A - A new dimension in airborne sea control {AIAA PAPER 74-239} MISSILE DESIGN Comparative study of various flight vehicle propulsion systems, using an air-to-air missile as an example {DGLR PAPER 73-068} A74-1717 MOMBITUR THEORY An unsteady wake model for a hingeless rotor MOMITORS Flight study of a vehicle operational status and monitoring system applied to systems on IP-12 aircraft [MASA-TN-D-7546] MOVING TARGET INDICATORS New concepts in AMTI radar - Hulling effects of Doppler filter/multi-element horn array A74-17252 N MASA PROGRAMS Putting all our noise technology to work MASA Quiet Engine Program A74-17045

174-18050

	MONDESTRUCTIVE TESTS	
HAVIER-STORES EQUATION	Ultrasonic inspection of titanium airframe	
Analysis of three-dimensional unsteady flow around oscillating wings	components	
[AIAA PAPER 74-184] A74-18838		1-16479
NAVIGATION AIDS	Non-destructive inspection of titanium jet end	42
Aircraft inertial system testing and evaluation in	disks a?	4-16480
the United Kingdom	Nondestructive detection of hydrides and	
NICKEL ALLOYS	alnha-case in titanium alloys	4-16482
Evolution of applications of precision casting in	Engineering appraisal of Southwest Research	
turbojets A74-17892	Institute magnetic crack definer applied to	CH47
MITRIC OXIDE	rotor blades	
Parameters controlling mitric oxide emissions from		4-14778
gas turbine combustors	Helicopter inspection design requirements [AD-769061] N7:	4-14781
N74-14291 A preliminary study on the influence of fuel	MAMMATILIBRION PLOW	
staging on nitric oxide emissions from gas	who affacte of hypersonic viscous interaction	ON atod
turbine combustors	static stability of slender bodies in simulation-equilibrium flows	aceu
W74-14301	1011-equilibrial 11010 . N7	4-14704
The effect of water injection on mitric oxide emissions of a gas turbine combustor burning	WORLINEAR SYSTEMS	
ASTM "Jet-A fuel	Decoupling of a class of nonlinear systems an application to an aircraft control problem	d its
[NASA-TH-I-2958] N/4-14650	application to an afficial control product	4-18139
EITROGEN OXIDES The jet engine design that can drastically reduce	Random wibration with non-linear damping	
oxides of nitrogen		4-18297
[AIAA PAPER 74-160] A74-18797	Experimental investigation of sonic boom	
Reduction of NO formations by premixing	propagation through variable flow fields	
Effect of increased fuel temperature on emissions	A/	4-16385
of oxides of nitrogen from a gas turbine	Noise from nonuniform turbulent flows	4-18722
combustor burning ASTM jet-A fuel	ALKE FORDE 14 23	
[NASA-TH-X-2931] N74-15659	nonplanar motion numerical analysis of	
NOISE GENERATORS The unsteady circulation distribution in rotors	aerodynamic force and moment systems during	
and its application to noise studies	large amplitude, arbitrary motions	4-14741
N74-14437	[NASA-TR-R-421] WOSE COMES	1 1 1 1 1 1 1
NOISE INTENSITY The spectrum of turbomachine rotor noise caused by	Supersonic flow past sharp- and blunt-nosed	
inlet quide vane vakes and atmospheric turbulence	conical bodies at angles of attack from 0 t	.0 45
N74-14379	deq [DGLE PAPER 73-080] A7	4-17186
NOISE POLLUTION Noise burden factor - New way of rating airport	WOZELE FLOW	
noise burden factor - see way of facting dispose	accomment of the influence of inlet and	
A74-16898	aftbody/nozzle performance on total aircraf	14-14726
Military aircraft and airport noise and opportunities for reduction without inhibition	Similarity parameters and their sensitivity f	or
of military missions	transonic airframe exhaust nozzle interacti	ons
[PB-223637/0GA] N74-13752	(ED-100300)	74-14746
HOISE PROPAGATION	NUMERICAL CONTROL Evaluation of the operations contained in	
Noise from nonuniform turbulent flows [AIAA PAPER 74-2] A74-18722		er
Research on noise generated by ducted air-fuel	computers	74-18638
combustion systems		74-10030
[AD-767337] N74-14445 NOISE REDUCTION	. 0	
Reduction of wibration and noise denerated by		
planetary ring gears in helicopter aircraft	OCEAN SURFACE Turning characteristics of the Bell 100 ton	
transmissions		
[ASME PAPER 73-PTG-11] A74-16979 Putting all our noise technology to work NASA	[AD-767680]	74-13753
Oniet Engine Program	OILS	rhina
A74-17049	Inproved silicone fluids as candidate gas tule engine oils for minus 40 F to 465 F tempera	ature
New jumbo jets wust speak in whispers - Certifying the Lockbeed 1011	range	
1/4-1/856	[AD-767898] W	74-14246
Propulsion system installations for aircraft	OMBOARD EQUIPARMY . Plight study of a vehicle operational status	and
A74-18179 The German law for protection against the noise of	monitoring system applied to systems of	n.
aircraft	YF-12 aircraft	
<u>174-18265</u>	Lunca III o 1546 1	74-13725
Sonic inlet noise attenuation and performance with	OPERATIONAL PROBLEMS Problems in data management for earth monitor	ring
a J-85 turbojet engine as a noise source [AIAA PAPER 74-91] A74-18768	missions	
Developmental design, fabrication, and test of	TOOL THEFT IS IT'S	74-17205
acoustic suppressors for fans of high bypass	Some current problems and prospects for development of rotary-wing aircraft	
turbofan engines		74-18641
Plight velocity effects on jet noise of several	OPERATIONS RESEARCH	
variations of a 46-tube suppressor installed on	Pailure modes, effects and criticality analy	S15
a plug nozzle	(PMECA) of category III instrument landing system with traveling: Wave localizer ant	
[NASA-TH-X-2919] N74-15465 Plight velocity effects on jet noise of several		74-15380
variations of a twelve-chute suppressor	OPTIMAL CONTROL	
installed on a pluq nozzle	Two numerical methods to solve realistic air-to-air combat differential games	
[NASA-TH-I-2918] N/4-15466	(AIAA PAPER 74-22)	74-18736

Differential-turning optimality criteria fo	
aircraft pursuit/evasion situations [AIAA PAPER 74-23] 174-	vehicle in Alaska
OPTINIZATION A74-	18737 (AD-768781) N74-14772 Failure modes, effects and criticality analysis
The use of fully stressed iteration and structure	(PMECA) of category III instrument landing
index in automated structural optimization	system with traveling: Wave localizer antenna
	17739 [U1-840912-100] #74-15380
The problem of optimal design of gas-turbine en	pines Microwave Landing System (MLS) development plan as 18083 proposed by Raytheon during the technique
Analytical design of optimal monolithic panels	analysis and contract definition phase of the
A74-	18642 national MLS development program. Volume 5:
Multi-input, multi-output regulator design for	Post Ta/CD plans, management performance
constant disturbances and non-zero set points with application to automatic landing in a	[PAA-RD-73-150-5] N74-15385 PHOTOCHENICAL REACTIONS
crosswind	Photo-oxidation of aircraft engine emissions at
	15378 low and high altitudes
OSCILLATING PLOW	H74-14277
Concepts for a theoretical and experimental stu- of lifting rotor random loads and vibrations,	
Phase 2	photochemical model with transport
[NASA-CR-114708] N74-	14756 N74-14278
_	PHOTOOXIDATION
P	Photo-oxidation of aircraft engine emissions at low and high altitudes
PAINTS	#74+14277
An aircraft exterior coating system and surface	PHYSIOLOGICAL EFFECTS
pretreatment	Atmospheric Pollution by Aircraft Engines [7862 [AGARD-CP-125] #74-14271
PANEL FLOTTER	[AGARD-CP-125] H74-14271 Pollution levels at London (Heathrew) Airport and
Theoretical investigation of supersonic flow page	t methods for reducing them
oscillating cascades with subsonic leading-ed-	Je 974-14284
locus	PILOT PERFORMANCE
(AIAA PAPER 74-14) A74-	8843 The simulation and analysis of carrier landings using a nonlinear pilot model
Analytical design of optimal monolithic panels	[AD-767679] N74-13747
174-	8642 PILOTLESS AIRCRAFT
PARACEUTE PARAICS	Some results of an experimental study of the
Bordineering evaluation of age life extension, T- barnesses, risers and T-10 troop chest reserve	10 Aerodyne concept by Dornier System GmbH DGLR PAPER 73-069 A74-17178
parachute camopies. Supplement 1: 1964 - 1969	
year classes	Suitability of using titanium pipelines in the
[AD-767711] N74-1	-,
Engineering evaluation of age life extension, T-	10 PITCHING MOMENTS A74-18090
barnesses, risers and T-10 troop chest reserve	Analysis of flow-reversal delay for a nitching
parachute canopies, Supplement 1: 1964 - 1965	airfoil
year classes [AD-767711] W74-1	[AIAA PAPER 74-183] A74-18835
PARAMETERIZATION	3743 PLASTIC AIRCRAFT STRUCTURES Designing with plastic resin matrix composite
Determination of the basic parameters of light	materials for aircraft structures
helicopters on the basis of the treatment and	[DGLR PAPER 73-086] A74-17192
analysis of statistical data A74-1	Experimental study of metal-plastic couplings in
PARTICLE DENSITY (CONCENTRATION)	8694 tension 174-18648
Particle sampling and size analysis in the	Experimental investigation of glass-plastic and
ejection zone of the Olympus jet engine at ground level	metal-plastic joints under shear
A74-1	7306 PLASTIC CONTINGS
PARTICLE SIZE DISTRIBUTION	An aircraft exterior coating system and surface
Particle sampling and size analysis in the	pretreatment
ejection zone of the Olympus jet engine at ground level	A74-17862
174-1	PLUG WOZZLES
Prosion prediction in turbomachinery due to	7306 Plight velocity effects on jet noise of several variations of a 48-tube suppressor installed on
environmental solid particles	a plug nozzle
[AIAA PAPER 74-16] A74-1 PARTICULATE SAMPLIEG	
Particle sampling and size analysis in the	Flight velocity effects on jet noise of several
ejection zone of the Olympus jet engine at	variations of a twelve-chute suppressor installed on a plug nozzle
ground level	f NASA-TM-X-29181 N74-15466
PASSENGER AIRCRAFT	
Skylacking and airport security	Aerodynamic forces and moments on a slender body
179-1	with a jet plume for angles of attack up to 180 degrees
PASSENGERS	[AIAA PAPER 74-110] A74-18776
The aftermath of a bijacking - Passenger claims and insurance	POLYURETHANE POAM
174-1	A sailplane wing constructed of foam core and 8101 polyester fiberglass skin
PATTERN RECOGNITION	(AIAA PAPER 74-258) A74-18665
An investigation of pattern recognition of	POLYURETHAND RESIDS
aircraft attitudes indicator displays [AD-768345]	An aircraft exterior coating system and surface
PERFORMANCE TESTS	F
Heavy Lift Helicopter main engines	POTRETIAL PLOS
[SAE PAPER 730920] 1 174-1	7537 Bowelespana of a mathed of
Sonic inlet noise attenuation and performance wi a J-85 turbolet engine as a noise source	
[AIAA PAPER 74-91] A74-1	study of compressible and incompressible flows
:: a	8768 A74-16968

Methods for the design and analysis of jet-	flapped	PROPULSION SYSTEM CONFIGURATIONS	lo.
airfoils [AIAA PAPER 74-186]	A74-18833	Comparative study of various flight vehic propulsion systems, using an air-to-air	e missile
Application of an improved unified	277 10000	as an example	
subsonic-supersonic potential flow method	for	[DGLR PAPER 73-068] Deutsche Forschungs- und Versuchsanstalt	174÷17177
the aerodynamic analysis of aircraft configurations		Luft- und Raumfahrt, Annual Report 1972	
[AIAA PAPER 74-186]	A74-18841	German book	
Calculation of potential flow about axially		•	A74-17969
symmetric fuselages, annular profiles and inlets	endine	Vertical take-off and landing aircraft	A74-18178
	N74-13707	Propulsion system installations for a	rcraft
POWDER METALLURGY		Q-FANSTM for general aviation aircraft	A74-18179
Status of the latest turbine disk alloys in	A74-17890	[NASA-CR-114665]	R74-13726
POWER SUPPLY CIRCUITS		LDF powered balloon program feasibili	y .
The ac power controllers for solid state		demonstration of free balloon station ke	sebrud
distribution system Yolume 1: Design, development, fabrication, and test of hyb	rid	[AD-768673]	N74-14770
devices		PROPULSION SYSTEM PERFORMANCE	lustion
[AD-768199] PREDICTION ANALYSIS TECHNIQUES	N74-13963	Exhaust system interaction program even of exhaust system installation losses at	
Computer prediction of aircraft noise		on aircraft performance	
	A74-19051	[AD-769086] PROTECTIVE COATINGS	H74-14747
Aircraft force protection model, Volume 1: quide to AFPN computer program to det		Fretting resistant coatings for titanium	illoys
aircraft inventory and operating requires	ents		A74-16592
[AD-767946] Microwave Landing System (MLS) development		PULSE RADAR Airborne profiling of ice thickness using	a short
proposed by AIL during the technique anal	lysis '	pulse radar	
and contract definition phase of the nati	ional'		A74-17810
MLS development program. Part 1.0, Volum Book 1: Post TACD development plan	10 1.2,	PURSUIT TRACKING pifferential-turning optimality criteria	for
[FAA-RD-73-166-VOL-1.2,1-BK-1]	N74-14341	aircraft pursuit/evasion situations	
A survey of drag prediction techniques appl	licable	(ATAN PAPER 74-23) PTLONS	A74-18737
to subsonic and transonic aircraft design	1 674-14711	A pylon to decrease the effects of extern	il stores
On some basic and new aspects about the dra		on the stability of aircraft	una 10740
problem of wings and bodies in supersonic	: flows N74-14713	[AD-767913]	N74-13749
Aircraft drag prediction for project apprai		0	
performance estimation		QUIET ENGINE PROGRAM	
Appendix: A data item service for aircraft		Putting all our noise technology to work	NASA
estimation collection, dissemination,	, and	Quiet Engine Program	878-17049
	, and on data		A74-17049
estimation collection, dissemination, development of aerodynamic drag prediction. Remarks on methods for predicting viscous of	, and on data N74-14717 lraq		A74-17049
estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous dependence of the development of the	, and on data N74-14717 Iraq Les of	R	A74-17049
estimation collection, dissemination, development of aerodynamic drag prediction. Remarks on methods for predicting viscous of	, and on data N74-14717 Iraq Les of	R BADAR BEACONS Field evaluation of SARTS 2 B (TRACAB)	
estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous of aerodynamic drag prediction for high anglattack and multielement airfoils PRESSURE DISTRIBUTION	, and on data x74-14717 lraq les of	RADAR BEACONS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf	
estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous of aerodynamic drag prediction for high anguattack and multielement airfoils PRESSURE DISTRIBUTION Application of an improved unified	, and on data N74-14717 Arag Les of N74-14718	R BADAR BEACONS Field evaluation of SARTS 2 B (TRACAB)	
estimation collection, dissemination, development of aerodynamic drag prediction. Remarks on methods for predicting viscous of aerodynamic drag prediction for high anglattack and multielement airfoils. PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft.	, and on data N74-14717 Arag Les of N74-14718	R BADAR BRACOMS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-76B203] Empirical assessment of ATCRBS perfor	fic N74-1436(mance of
estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous of aerodynamic drag prediction for high angulattack and multielement airfoils PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations	, and on data N74-14717 lrag les of N74-14718	R BADAR BEACONS Pield evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-768203] Empirical assessment of ATCRBS perfor air traffic control digital processing	fic N74-1436C mance of system
estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous of aerodynamic drag prediction for high angulation attack and multielement airfoils PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations	, and on data N74-14717 lrag les of N74-14718 lfor A74-18841	R RADAR BEACONS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-768203] Empirical assessment of ATCRBS perfor air traffic control digital processing [ATC-16] RADAR ECHOES	fic N74-1436(mance of
estimation collection, dissemination, development of aerodynamic drag prediction. Remarks on methods for predicting viscous of aerodynamic drag prediction for high angulation attack and multielement airfoils. PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations. [AIAA PAPER 74-186] The flow field and pressure distribution of isolated road wheel	, and on data N74-14717 lrag les of N74-14718 i for A74-18841 f an	R RADAR BEACONS Pield evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-768203] Empirical assessment of ATCRBS perfor air traffic control digital processing [ATC-16] RADAR ECHOES Aircraft velocity measurement through	fic N74-1436C mance of system N74-15379
estimation collection, dissemination, development of aerodynamic drag prediction. Remarks on methods for predicting viscous of aerodynamic drag prediction for high anglattack and multielement airfoils. PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations. [AIAN PAPER 74-186] The flow field and pressure distribution of isolated road wheel [IC-AERO-72-14]	, and on data N74-14717 lrag les of N74-14718 d for A74-18841 f an N74-14706	R RADAR BEACONS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-768203] Empirical assessment of ATCRBS perfor air traffic control digital processing [ATC-16] RADAR ECHOES	fic N74-1436C mance of system N74-15379
estimation collection, dissemination, development of aerodynamic drag prediction. Remarks on methods for predicting viscous of aerodynamic drag prediction for high angulation attack and multielement airfoils. PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations. [AIAA PAPER 74-186] The flow field and pressure distribution of isolated road wheel	, and on data N74-14717 lrag les of N74-14718 i for A74-18841 f an N74-14706 ts of	R BADAR BEACONS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-768203] Empirical assessment of ATCRBS perfor air traffic control digital processing [ATC-16] RADAR ECHORS Aircraft velocity measurement through radar-altimeter echo: A theoretical in [SLA-73-669] RADAR EQUIPMENT	fic N74-1436C mance of system N74-15379 vestigation N74-14119
estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous derodynamic drag prediction for high anglattack and multielement airfoils PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations [AIRA PAPER 74-186] The flow field and pressure distribution of isolated road wheel [IC-AERO-72-14] Drag in hypersonic rarefied flow effect cold pressure drag and friction drag	, and on data N74-14717 lrag les of N74-14718 3 for A74-18841 f an H74-14706 ts of	R BADAR BEACONS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-76B203] Empirical assessment of ATCRBS perfor air traffic control digital processing [ATC-16] RADAR ECHORS Aircraft velocity measurement through radar-altimeter echo: A theoretical in [SLA-73-669] RADAR BOULPMENT Air traffic control long term plannin	fic N74-1436C mance of system N74-15379 vestigation N74-14119
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estimation collection, dissemination, development of aerodynamic drag prediction Remarks on methods for predicting viscous aerodynamic drag prediction for high anglattack and multielement airfoils PRESSURE DISTRIBUTION Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations [AIAM PAPER 74-186] The flow field and pressure distribution of isolated road wheel [IC-AERO-72-14] Drag in hypersonic rarefied flow effect cold pressure drag and friction drag PRESSURE RPFECTS Inviscid wake-airfoil interaction on multichigh lift systems PRESSURE MEASUREMENTS Comparison of various methods for calculated profile drag from pressure measurements mear wake at subcritical speeds PRODUCTION ENGINEERING Microwave Landing System (MLS) development proposed by Raytheon during the technique analysis and contract definition phase on mational MLS development program. Volume Post TA/CD plans, management performance [FAA-RD-73-150-5]	, and on data x74-14717 lrag les of x74-14718 i for x74-14716 ts of x74-14706 ts of x74-14730 element x74-18143 ing in the x74-14721 plan as ef the e 5:	RADAR BEACONS Field evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-76823] Empirical assessment of ATCRBS perfor air traffic control digital processing [ATC-16] RADAR ECHOES Aircraft velocity measurement through radar-altimeter echo: A theoretical in [SLA-73-669] RADAR BOULTMENT Air traffic control long term plannin Germany Pield evaluation of ARTS 2 B (TRACAB) evaluation of radar beacon for air traf control applications [AD-768203] RADAR FILTERS New concepts in ANTI radar - Nulling effe Doppler filter/multi-element horn array RADAR MEASUREMENT Airborne profiling of ice thickness using pulse radar RADAR TARGETS Empirical assessment of ATCRBS perfor	fic N74-1436C mance of system N74-15379 vestigation N74-14119 q in A74-18182 fic N74-1436C cts of A74-17252 a short L74-1781C mance of
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RADIO TRANSBITTERS SUBJECT LEDEX

RADIO TRANSMITTERS		BESOTE CONTROL	
Air traffic control long term planning	in	Design and hover-flight testing of a deflecti	.oo
Germany	A74-18182	control system for the herodyne wingless,	.1.
RAIN IMPACT DAMAGE	V14-10105	remote-controlled experimental flight webic	:1 0 /4-17179
On the problem of rain erosion on a moving	bodv	REMOTE SENSORS	4-17172
flying at supersonic speed	,	Problems in data management for earth monitor	ing
	A74-16727	#issions	-
RAUDON VIBRATION			4-17295
Randon vibration with non-linear damping	- 70 40007	RESEARCH AND DEVELOPMENT	
BARRFIED GAS DYNAMICS	A74-18297	Helicopter modelling /18th Henson and Stringf	.etfom
Drag in hypersonic rarefied flow effec	ts of	Lecture/ exploratory, development and research models	
cold pressure drag and friction drag			4-18299
,	N74-14730	BESEARCH PROJECTS	
RAYLEIGH-RITE METHOD		United States Department of Transportation	
A direct method for calculating flutter sp		research program for high altitude pollution	
[AIAA PAPER 74-27]	A74-18675		4-14273
BRACTION WHEELS Dynamics of slung bodies utilizing a rotat.	ina	Technical Evaluation report application of aerodynamic drag research to design of airc	
wheel for stability			4-14710
	A74-18141	BRYERSED FLOW	
RECORBAISSANCE AIRCRAFT		Analysis of flow-reversal delay for a pitchin	q
The S-3A - A new dimension in airborne sea		airfoil	
(AIAA PAPER 74-239)	174-19205		4-18835
RECTANGULAR WINGS A direct method for calculating flutter sp	o a fina	RETWOLDS WOMBER	
[AIAA PAPER 74-27]	A74-18675	Integral equation method for calculation of subsonic flow past airfoils in a ventilated	wind
Calculation of the aerodynamic characteris		tunnel - Comparison with WAE high Reynolds	
a wing system moving at subsonic speed n	ear land	number measurements	
or smooth water surface			4-18764
	174-18681	RIBS (SUPPORTS)	_
REFINING The refining of turbine fuels by modern		Buckling loads and minimum weight of compress	ed
hydrotreating		curved ribbed aluminum allow panels	4-16822
(AIAA PAPER 74-1621	A74-18798	RIGID ROTORS	4-10022
Supersonic fuels from medium oils produced		Nonstationary vibrations of a rigidly support	.ed
thermal cracking of crude oil residues		flexible rotor of variable mass	
[DFVLR-SONDDR-301]	A74-18925		4-17851
REPRIGRATING		An unsteady wake model for a hingeless rotor	
Refrigerated containerized transport for 'a	Jumbo'		4-18140
jets	A74-17007	RIGID STRUCTURES An analytic approximate calculation of the	
REGIONAL PLANNING		nonlinear landing impact motions and loads	on
An innovative approach to airport planning		aircraft with both rigid and elastic wing	
	A74~18099	structure	
REGRESSION ANALYSIS			4-17185
A study of the damageability of turbine bla		RING STRUCTURES	
aircraft qas-turbine engines after opera- running in	tional	Reduction of vibration and noise generated by	
rankind in	A74-18085	planetary ring gears in helicopter aircraft transmissions	
REIMPORCED PLASTICS	2.1 10005		4-16979
Designing with plastic resin matrix compos.	ite	ROCKET LAUNCHERS	
materials for aircraft structures		Methods for reducing vibrations of equipment	
[DGLR PAPER 73-086]	A74-17192	mounted on helicopter external stores stati	.ons
Experimental study of metal-plastic coupling tension	ngs in	damping of vertical vibrations of	
***************************************	A74-18648	wing-mounted stores on AH-1G helicopter [AD-768774] 87	4-14771
Experimental investigation of glass-plastic		ROLLING	4-14771
metal-plastic joints under shear		Flat rolled beta titanium alloys for airframe	
	A74-18697	application	
Development of a graphite horizontal stabi	lizer		4-16449
structural analysis of static ultimated and simulated fatique spectrum loading	te load	ROLLING MOMENTS	
(AD-768869)	N74-14783	Lifting-surface theory for an oscillating T-t	a11 4-17012
REINFORCEMENT (STRUCTURES)	277 14705	Beasurements of rolling moments acting on the	
Analytical and experimental investigation (of	stabilizer of T-tails oscillating in yaw	
aircraft metal structures reinforced wit			4-14744
filamentary composites. Phase 3: Major		ROTARY STABILITY	
component development [NASA-CR-2122]	W70 4060E	Nonstationary vibrations of a rigidly support	eđ
RELAXATION METHOD (MATERNATICS)	H74-14625	flexible rotor of variable mass	A. 470E4
Belaxation methods for transonic flow about	t	ROTARY WING AIRCRAFT	4-17851
wing-cylinder combinations and lifting s		Rotary-wing aircraft	
·	A74-16951		4-18177
A relaxation method for calculating transo	nic	Some current problems and prospects for	
flows with detached bow shocks	17h 400=4	development of rotary-wing aircraft	
BELIABILITY AWALYSIS	174-16970	ROTARY WINGS	4-18641
Theory and practice of avionics reliability	₹	Analysis of stall flutter of a helicopter rad	
	174-18597	plage or scall tidefet of a Wellcobiel Lag	
Importance of the means of engine condition	a		4-13708
surveillance		Dynamic stall	
Rivereds and enchange of the title	A74~18598		4-13709
<pre>lircraft and systems reliability relat: overhaul and maintenance</pre>	100 to	The stability of helical vortex filaments in	the
	174-18599	wake of a hovering rator	4-13713
		87	

Effect of compressibility on three-dimens	ional	c	
belicopter rotor blade flutter	B74-13714	S	
Barch 1971 wind tunnel tests of the Doran		S-W DIAGRAMS	ades of
jet flap rotor, volume 1		S-W Digusters A study of the damageability of turbine bl aircraft gas-turbine engines after opera	tional
rwasa-cp-1106931	N74-13722	running in	
Transmission thermal mapping (CH-47C form	ara rotor	Indiana	A74-18085
transmission) (AD-767875]	N74-13732	S-3 AIRCRAFT	. control
Concents for a theoretical and experiment	al study	The 5-3A - A new dimension in airborne sea	A74-19205
of lifting rotor random loads and wibra	tions,	[AIAA PAPER 74-239] S-61 HELICOPTER	
Phase 2	N74-14756	telegratic control of a helicopter with a h	anging
[NASA-CR-114708] Concepts for a theoretical and experiment	al study	load development and evaluation of a	utomatic
of lifting rotor random loads and Vibra	tions	pilot for use with 5-61 helicopter (NASA-CR-136504)	N74-13715
(the effects of some rotor feedback sys	stems on	CITO CODIT TESTS	
rotor-body dynamics), Phase 7-A [NASA-CR-114709]	N74-14757	Hot-salt stress-corrosion of titanium allo	ys as
Similarity requirements for aeroelastic	odels of	related to turbine engine operation	A74-1660G
helicopter rotors	¥74-14767	SATELLITE OBSERVATION	
[ARC-CP-1245] Recommended design modifications to the C		Problems in data management for earth moni	toring
forward rotor drive gearbox		missions	A74-17205
[AD=769062]	N74-14775	[DGLR PAPER 73-109] SCALE MODELS	
Engineering appraisal of Southwest Reseat Institute magnetic crack definer applic	con ed to CH47	Models in the design of fuel systems	- 01: 46750
rotor blades			374-16758
[AD-769068]	N74-14778	Helicopter modelling /18th Henson and Stri Lecture/ exploratory, development as	nd
OTATING BODIES	16	research models	
The determination of non-symmetric vehic stability parameters from response date	1		A74-18299
	8/4-13/02	SCHLIBREN PHOTOGRAPHI	
Magnus characteristics of arbitrary rota	ting bodies N74-13710	A color schlieren syste∎	A74-17806
(AGARD-AG-171)	N/4-13/10	The stability of helical vortex filaments	in the
OTOR ARRODYNAMICS Concepts for a theoretical and experimen	tal study	wake of a howering rotor	N74-13713
of lifting rotor random loads and wibr	ations,	SEALS (STOPPERS)	11-12-13
Phase 1	x74-14755	Improved circumferential shaft seal for a	ircraft
[MASA-CR-114707] Concepts for a theoretical and experimen	tal study	gear transmissions	N74-14138
of lifting rotor random loads and wibr	ations,	[WASA-TW-D-7130]	N74-14130
Phase 2	N74-14756	SEARCH RADAR User's manual for ILSLOC: Simulation for	
[NASA-CR-114708] Concepts for a theoretical and experimen	tal study	derogation effects on the localizer por	tion of
of lifting rotor random loads and VIDE	ations	the instrument landing system	N74-14361
the effects of some rotor feedback sy	stems on	(AD-768049] SECURITY	
rotor-body dynamics), Phase 7-1 [HASA-CR-114709]	N74-14757	Skyjacking and airport security	.70 40400
concents for a theoretical and experimen	tal study	ADGRETTERE GEORGE	A74-18109
of lifting rotor random loads and wibr	ations	SELF ORGANIZING SYSTEMS A self-reorganizing digital flight contro	1 system
(identification of lifting rotor syste parameters from transient response dat	a), Phase	for aircraft	
7-B		[AIAA PAPER 74-21]	A74-18808
[NASA-CR-114710]	N74-14758	SEPARATED FLOW Calculation of separated flows at subsoni	.cand.
Concepts for a theoretical and experimen of lifting rotor random loads and wibr	ations	transonic speeds	
(further experiments with progressing/	reqressing		A74-16965
rotor flapping modes), Phase 7-C	N74-14759	A color schlieren system	A74-17806
(NASA-CB-114711) ROTOR BLADES	8/4-14/33	Numerical investigation of vortex sheets	issuing
concepts for a theoretical and experimen	ital study	from a separation line near the leading	g edge A74-18289
of lifting rotor random loads and wibs	ations,	Drag and separation effects of separa	
Phase 1	N74-14755	on aerodynamic drag	
[NASA-CR-114707] Concepts for a theoretical and experimen	ntal study		N74-14722
of lifting rotor random loads and Vibr	ations	Analysis of the flow about delta wings wings wings wings wings are leading edge separation at supersonic s	.ta speeds
(identification of lifting rotor system parameters from transient response date)	(NASA-CR-132358)	N74-14745
7-B	Lay, Flado	STEATOR LIPR	44
f v1 c1_cp_ 114710 1	N74-14758	Engineering evaluation of age life extens harnesses, risers and T-10 troop chest	TOOR, T-10
concerts for a theoretical and experimen	ntal study	parachute canopies. Supplement 1: 196	1965
of lifting rotor random loads and wibs (further experiments with progressing,	/regressing	year classes	
rotor flapping modes), Phase 7-C		[10-767711]	874-13743
[NASA-CR-114711]	N74-14759	SERVOCONTROL The Type 3B altitude measurement system	
BOTORS V/STOL tilt rotor mircraft study. Yolu	ne 10:	ING 1456 30 dicteder morpholis state	A74-17276
no-governo and stability test of A l'	-14.022	SHAPTS (MACHINE BLBBENTS)	-1
Proude scaled Boeing Vertol Model 222	tilt rotor	Improved circumferential shaft seal for a gear transmissions	TEGLATE
aircraft (Phase 1)	N74-13727	[WASA-TH-D-7130]	N74-14130
[MASA-CR-114603]		SEARP LEADING EDGES	
mbommal and chamical for dissipation:	Results of	Supersonic flow past sharp- and blunt-no- conical bodies at angles of attack fro	sed m () to 45
field experiments at Vandenberg APB,	Calliorn18	ged Coulcal bodies at andles of accept its	
during July 1972 [AD-768671]	N74-15367	f DGLR PAPER 73-0801	A74-17186
(· · · · · · · · · · · · · · · · · ·		Analysis of the flow about delta wings w leading edge separation at supersonic	ıta speeds
		[NASA-CR-132358]	N74-14745

SHRAH STRENGTH	SHROUDED PROPELLERS
Development of cold headable titanium alloys for	Improvement of the downflow conditions behind an
the 'Concorde' supersonic jet	integrated shrouded propeller
SHRAR STRESS A74-16554	A74-17801
Experimental investigation of glass-plastic and	SIGHAL PADING
metal-plastic joints under shear	Aircraft velocity measurement through radar-altimeter echo: A theoretical investigation
A74-18697	[SLA-73-669] Theoretical investigation
Jet noise modeling - Experimental study and models	SIGNAL PROCESSING
for the noise and turbulence fields	New concepts in AMTI radar - Nulling effects of
[Alaa Paper 74-3] A74-18723 SHOCK SIBULATORS	Doppler filter/multi-element horn array
Recent developments in sonic-boom simulation using	A74-17252
shock tubes	SILICOVES
A74-16384	Improved silicone fluids as candidate gas turbine
SHOCK TUBES	engine oils for minus 40 P to 465 P temperature
Recent developments in sonic-boom simulation using	[AD-767898] N74-14246
shock tubes	SINGULABITI (MATREMATICS)
A74-16384	Development of a method of
SHOCK WAVE INTERACTION	discretized-distribution singularities for the
A direct method for computing the steady flow at Mach number one past a given wing airfoil	study of compressible and incompressible flows
A74-16963	A74-16968
SHOCK MATE PROFILES	SIER DETERMINATION
Supersonic flow past sharp- and blunt-nosed	Particle sampling and size analysis in the ejection zone of the Olympus jet engine at
conical bodies at angles of attack from 0 to 45	ground level
đeq	A74-17306
[DGLR PAPER 73-080] A74-17186	SKIB (STRUCTURAL MEMBER)
SHOCK WAVE PROPAGATION	A sailplane wing constructed of foam core and
Experimental investigation of sonic boom propagation through variable flow fields	polyester fiberglass skin
174-16385	[AIAA PAPER 74-258] A74-18665
SHOCK WAVES	SKIN PRICTION
A relaxation method for calculating transonic	Review of drag measurements from flight tests of manned aircraft with comparisons to wind-tunnel
flows with detached bow shocks	predictions
A74-16970	N74-14735
SHORT HAUL AIRCRAFT	SLEADER BODIES
Performance characteristics of short haul transport aircraft intended to operate from	herodynamic forces and moments on a slender body
reduced length runways	with a jet plume for angles of attack up to 180
[CRANFIELD-AERO-18] N74-13716	degrees
SEORT TAKBOFF AIRCRAFT	(AIAA PAPER 74-110) A74-18776 SLENDER WINGS
The influence of wing loading on turbofan powered	A vortex entrainment model applied to slender
STOL transports with and without externally	delta udana ander applied to signer
	derta winds
blown flaps	delta wings
[NASA-CR-2320] N74-13719	Numerical investigation of vorter sheets issuing
[NASA-CR-2320] Takeoff and landing performance and noise	Numerical investigation of vorter sheets issuing
[NASA-CR-2320] N74-13718 Takeoff and landing performance and noise measurements of a deflected slipstream STOL	A74-17029 Numerical investigation of vortex sheets issuing from a separation line near the leading edge A74-18289
[NASA-CR-2320] N74-13718 Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-13720]	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TM-X-62320] Harch 1971 wind tunnel tests of the porand DH 2011	Numerical investigation of vorter sheets issuing from a separation line near the leading edge 174-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [ATAL PAPER 74-258]
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TM-X-62320] March 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transpace flow about
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TB-Y-62320] Barch 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-714694] NAM-CR-714694	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transpace flow about
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TB-Y-62320] Harch 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2:	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A Bailplane wing constructed of foam core and polyester fiberglass skin [ATAA PAPER 78-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-1-62320] March 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] N74-13733	Numerical investigation of vortex sheets issuing from a separation line near the leading edge 174-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [ATA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings 174-16951 Transonic flow about lifting wing-body combinations
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TB-Y-62320] March 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 8:	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] A74-18665 SHALL PRETURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185]
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TM-X-62320] March 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [ATAA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [ATAA PAPER 74-185] SOCIAL FACTORS
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-1-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-TR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363]	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 76-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-Y-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 2: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 4: Volume 5: Volume 5: Volume 5: Volume 5: Volume 6: Volume 7: Volume 6: Volume 6: Volume 6: Volume 6: Volume 6: Volume 7: Volume 7: Volume 6: Volume 6: Volume 7: Volume 7: Volume 6: Volume 7: Volume 6: Volume 7: Volume 6: Volume 7: Volu	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [ATAA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [ATAA PAPER 74-185] SOCIAL FACTORS
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TB-Y-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 2: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 4: Vind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Flight control technology	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 78-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-Y-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] STOL tactical aircraft investigation. Volume 5: STOL tactical aircraft investigation. Volume 5: STOL tactical aircraft investigation. Volume 5: STOL tactical aircraft investigation. Volume 6:	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PRETURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL HOISTURE
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-Y-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] STOL tactical aircraft investigation. Volume 5: STOL tactical aircraft investigation. Volume 5: STOL tactical aircraft investigation. Volume 5: STOL tactical aircraft investigation. Volume 6:	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] A74-18665 SHALL PRETURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] A74-18812 SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL BOISTURE Ground contamination by fuel jettisoned from
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-16230] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300]	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIRA PAPER 74-258] SHALL PRETURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIRA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL MOISTURE Ground contamination by fuel jettisoned from aircraft
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-16230] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767561] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 4: Plight control technology [AD-767364] STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] STOL tactical aircraft investigation. externally	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PRETURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL MOISTURE Ground contamination by fuel jettisoned from aircraft
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-X-62320] B74-13720 Barch 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] STOL tactical aircraft investigation. Volume 9: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Flight control technology [AD-767364] STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] STOL tactical aircraft investigation, externally blown flap. Volume 1: Configuration	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PRETURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL BOISTURB Ground contamination by fuel jettisoned from aircraft SOLID STATE DEVICES
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TR-162320] Harch 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] STOL tactical aircraft investigation. Volume 5: Air cushion and ground mobility study [AD-767300] STOL tactical aircraft investigation, externally blown flap. Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL HOISTURE Ground contamination by fuel jettisoned from aircraft SOLID STATE DEVICES The ac power controllers for solid state distribution system. Volume 1: Design.
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Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-162320] N74-13720 March 1971 wind tunnel tests of the Dorand DH 2011 [let flap motor, volume 2 [NASA-TH-114694] N74-13723 STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] N74-13734 STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] N74-13735 STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] N74-13736 STOL tactical aircraft investigation, externally blown flap. Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system [AD-767179] N74-13754 STOL tactical aircraft investigation, externally blown flap. Volume 3: Performance methods and landing rules [AD-7671801]	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 78-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-1651 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL HOISTURE Ground contamination by fuel jettisoned from aircraft SOLID STATE DEVICES The ac power controllers for solid state distribution system. Volume 1: Design, development, fabrication, and test of hybrid devices [AD-768199] SOLIDS FLOW Erosion prediction in turbomachinery due to
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[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-7-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-TH-7-14654] STOL tactical aircraft investigation. Volume 2: Design compendium N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis N74-13734 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis N74-13734 STOL tactical aircraft investigation. Volume 5: Flight control technology N74-13735 STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study N74-13736 STOL tactical aircraft investigation, externally blown flap. Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system N74-13754 STOL tactical aircraft investigation, externally blown flap. Volume 3: Performance methods and landing rules AD-767180] STOL tactical aircraft investigation, externally blown flap. Volume 3: Performance methods and landing rules AD-767180] STOL tactical aircraft investigation, externally blown flap. Volume 5, part 1: Control system mechanization trade studies AD-767181] STOL tactical aircraft investigation, externally blown flap. Volume 5, part 3: Stability and control derivative accuracy requirements and effects of augmentation system design N74-13757 A study of the effect of flight design N74-13757	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 78-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL MOISTURE Ground contamination by fuel jettisoned from aircraft SOLID STATE DEVICES The ac power controllers for solid state distribution system. Volume 1: Design, development, fabrication, and test of hybrid devices [AD-768199] SOLIDS PLOW Erosion prediction in turbomachinery due to environmental solid particles [AIAA PAPER 74-16] SONIC BOOMS Recent developments in sonic-boom simulation using shock tubes A74-16385 SPACE TRANSPORTATION Military and aerospace cost effective
Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-162320] B74-13720 Harch 1971 wind tunnel tests of the Dorand DH 2011 jet flap motor, volume 2 [NASA-CR-114694] N74-13723 STOL tactical aircraft investigation. Volume 2: Design compendium [AD-767551] N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis [AD-767363] N74-13734 STOL tactical aircraft investigation. Volume 5: Plight control technology [AD-767364] N74-13735 STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study [AD-767300] N74-13736 STOL tactical aircraft investigation, externally blown flap. Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system [AD-767179] STOL tactical aircraft investigation, externally blown flap. Volume 3: Performance methods and landing rules [AD-767180] N74-13755 STOL tactical aircraft investigation, externally blown flap. Volume 5, part 1: Control system mechanization trade studies [AD-767181] N74-13756 STOL tactical aircraft investigation, externally blown flap, Volume 5, part 1: Control system mechanization trade studies [AD-767181] N74-13756 STOL tactical aircraft investigation, externally blown flap, Volume 5, part 3: Stability and control derivative accuracy requirements and effects of augmentation system design [AD-767182] A study of the effect of flight density and background noise on VSTOL acceptabilian	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 78-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16551 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL PACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL HOISTURE Ground contamination by fuel jettisoned from aircraft SOLID STATE DEVICES The ac power controllers for solid state distribution system. Volume 1: Design, development, fabrication, and test of hybrid devices [AD-768199] SOLIDS FLOW Erosion prediction in turbomachinery due to environmental solid particles [AIAA PAPER 74-16] SONIC BOOMS Recent developments in sonic-boom simulation using shock tubes Experimental investigation of sonic boom propagation through variable flow fields SPACE TRAWSPORTATION Military and aerospace cost effective technology utilization for ATC, MASA programs
[NASA-CR-2320] Takeoff and landing performance and noise measurements of a deflected slipstream STOL airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-7-62320] March 1971 wind tunnel tests of the Dorand DH 2011 let flap motor, volume 2 [NASA-TH-7-14654] STOL tactical aircraft investigation. Volume 2: Design compendium N74-13733 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis N74-13734 STOL tactical aircraft investigation. Volume 4: Wind tunnel data analysis N74-13734 STOL tactical aircraft investigation. Volume 5: Flight control technology N74-13735 STOL tactical aircraft investigation. Volume 6: Air cushion and ground mobility study N74-13736 STOL tactical aircraft investigation, externally blown flap. Volume 1: Configuration definition. Supplement 1: Aerodynamic trades of flap and roll control system N74-13754 STOL tactical aircraft investigation, externally blown flap. Volume 3: Performance methods and landing rules AD-767180] STOL tactical aircraft investigation, externally blown flap. Volume 3: Performance methods and landing rules AD-767180] STOL tactical aircraft investigation, externally blown flap. Volume 5, part 1: Control system mechanization trade studies AD-767181] STOL tactical aircraft investigation, externally blown flap. Volume 5, part 3: Stability and control derivative accuracy requirements and effects of augmentation system design N74-13757 A study of the effect of flight design N74-13757	Numerical investigation of vorter sheets issuing from a separation line near the leading edge A74-18289 A sailplane wing constructed of foam core and polyester fiberglass skin [AIAA PAPER 74-258] SHALL PERTURBATION FLOW Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic flow about lifting wing-body combinations [AIAA PAPER 74-185] SOCIAL FACTORS Aviation needs and public concerns civil aviation growth in Europe and environmental control SOIL MOISTURE Ground contamination by fuel jettisoned from aircraft SOLID STATE DEVICES The ac power controllers for solid state distribution system. Volume 1: Design, development, fabrication, and test of hybrid devices [AD-768199] SOLIDS FLOW Erosion prediction in turbomachinery due to environmental solid particles [AIAA PAPER 74-16] SONIC BOOMS Recent developments in sonic-boom simulation using shock tubes Experimental investigation of sonic boom propagation through variable flow fields SPACE TRANSPORTATION

SUBJECT INDEX STRUCTURAL STRAIN

SPACECRAPT STRUCTURES	Static and dynamic helicopter airframe analysis
Structural materials of aeronautics and astronautics	with NASTRAN N74-14616
174-18190	WASTRAW data generation of helicopter fuselages
SPEED CONTROL Problem of adapting an intake to a turbolet engine	neing interactive graphics preprocessor
for extremely high flight Mach numbers	system for finite element analysis using IBM
174-17272	computer 874-14621
SPOOLS /	emprement DPSTCE
The effect of inlet distortion on the performance	Designing with plastic resin matrix composite
and stability of the low-speed spool of a turbofan engine	materials for aircraft structures
[AIAA PAPER 74-234] A74-18855	[DGLR PAPER 73-086] A74-17192
STABILIZED PLATFORMS	Materials for the new generation of aircraft A74-17374
Aircraft inertial system testing and evaluation in	Wing fuselage structural/concept study for a
the United Kingdom N74-14352	subsonic transport aircraft
STAGNATION POINT	[SAE PAPER 730886] A74-17533
On the problem of rain erosion on a moving body	Application of advances in structures and materials to the design of the FF-17 airplane
flying at supersonic speed A74-16727	(SIR PAPER 7308911 A74-17534
STATIC LOADS	The use of fully stressed iteration and structural
Static and dynamic belicopter airframe analysis	index in automated structural optimization
with NASTRAN	Structural materials of aeronautics and astronautics
B74-14616	A74-1819C
STATIC TESTS A 300 B static and fatigue tests	Analytical design of optimal monolithic panels
174-16755	A74-18642
STATIONKEEPING	An algorithm for rational selection of the parameters of nonlinearly deforming thin-walled
LDF powered balloon program feasibility	framework elements
demonstration of free balloon station keeping	A74-18645
capability [AD-768673] 874-14770	Application of damage tolerance technology to
STATISTICAL AWALISIS	advanced metallic fighter wing structure
Determination of the basic parameters of light	[AIAA PAPER 74-29] On repetitive flutter calculations in structural
helicopters on the basis of the treatment and	design
analysis of statistical data	FATAA PAPER 74-1411 A74-18789
STEADY, PLOW	Section 3: Stability, construction materials,
A direct method for computing the steady flow at	construction methods 974-14670
Mach number one past a given wing airfoil	Recommended design modifications to the CH-47
A method of calculating the flow around a wing of	forward rotor drive qearbox
arbitrary planform, positioned on a cylindrical	[AD-769062] N74-14775
gibitiata biguiofm' bositioned on a citragradar	TT TTT TTT A 1
bod∀	Optimisation of aircraft structures with multiple
body 174-18632	Optimisation of aircraft structures with multiple stiffness requirements N74-15612
body A74-18632	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of
body A74-18632 STEELS Aircraft components from remelted steels - Design and development	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure
body A74-18632 STERLS Aircraft components from remelted steels - Design and development A74-17887	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STEATOSPHERE Temperature, winds, and turbulence at SST flight	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of gas-turbine engines
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Otility analysis in weight control The problem of optimal design of gas-turbine engines A74-18083 Study of structural criteria for composite airframes. Volume 1: Evaluation
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation fAD-7677061
body A74-18632 STRELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Otility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Utility analysis in weight control The problem of optimal design of gas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected
body A74-18632 STEELS AirCraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Indestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere FAIAA PAPER 74-421 A74-18815	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Otility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation [AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation
body A74-18632 STEELS AirCraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] N74-14239 Similarity requirements for aeroelastic models of
body A74-18632 STEELS AirCraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone laver, studied in a two-dimensional photochemical model with transport	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of gas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes, Volume 2: Current/criteria/selected rationale review and evaluation (AD-767707) Similarity requirements for aeroelastic models of helicopter rotors
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation [AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] N74-14767
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Utility analysis in weight control The problem of optimal design of gas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes, Volume 2: Current/criteria/selected rationale review and evaluation (AD-767707) Similarity requirements for aeroelastic models of helicopter rotors (ARC-CP-1245) M74-14767
body STEELS AirCraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone laver, studied in a two-dimensional photochemical model with transport STEESS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Otility analysis in weight control The problem of optimal design of gas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STEENSS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation A74-16600	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with MASTRAN N74-14616
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRENSS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation A74-16600 Fracture mechanics /Dryden Lecture/ aerospace	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITBRIA Otility analysis in weight control The problem of optimal design of gas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes, Volume 2: Current/criteria/selected rationale review and evaluation (AD-767707) Similarity requirements for aeroelastic models of helicopter rotors (ARC-CP-1245) STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN N74-14616
STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation A74-16600 Fracture mechanics /Dryden Lecture/ aerospace structural design applications	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINERRING STRUCTURAL ENGINERRING STRUCTURAL HEMBERS The testing of jet engines, Chapters 5 and 6
STEELS Aircraft components from remelted steels - Design and development STRATOSPHERE Temperature, winds, and turbulence at SST flight levels Stratosphere contamination by aircraft and mathematical models Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CRACKING Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STRESS RATTO	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Utility analysis in weight control A74-17740 The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation (AD-767707) Similarity requirements for aeroelastic models of helicopter rotors (ARC-CP-1245) STRUCTURAL REGINERRING STRUCTURAL REGINERRING STRUCTURAL HEMBERS The testing of jet engines, chapters 5 and 6 test stand structure (AD-768492) N74-15467
body A74-18632 STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CEACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STRESS BATTO The use of fully stressed iteration and structural	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Ottlity analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN N74-14616 STRUCTURAL ENGINEERIS The testing of jet engines, Chapters 5 and 6 test stand structure [AD-768492] STRUCTURAL STABILITY
body STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAN PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation A74-1666C Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] STRESS RATIO The use of fully stressed iteration and structural index in automated structural optimization	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN N74-14616 STRUCTURAL ENGINEERING The testing of jet engines, chapters 5 and 6 test stand structure [AD-768492] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles
body STEELS AirCraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels Stratosphere contamination by aircraft and mathematical models A74-17311 Indestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STEESS CORROSION CEACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STEESS BATTO The use of fully stressed iteration and structural index in automated structural optimization A74-17739	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Ottlity analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN N74-14616 STRUCTURAL ENGINEERING STRUCTURAL ENGINEERING The testing of jet engines, Chapters 5 and 6 test stand structure [AD-768492] STRUCTURAL STRBILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] N74-13954
STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAN PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation A74-16660 Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] STRESS RATIO The use of fully stressed iteration and structural index in automated structural optimization A74-17739 STRUCTURAL MAALYSIS Effects of Ti-6A1-4v alloy metallurgical	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN N74-14616 STRUCTUBAL MEMBERS The testing of jet engines, chapters 5 and 6 test stand structure [AD-768492] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] STRUCTUBAL STABILITY Restraint procedures for light aircraft using NASTRAN
STEELS Aircraft components from remelted steels - Design and development A74-17887 STENTOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STENTS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STEESS RATIO The use of fully stressed iteration and structural index in automated structural optimization A74-17739 STRUCTURAL ANALYSIS Effects of Ti-6Al-4V alloy metallurgical structures on ultrasonic response characteristics	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation [AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL REGIMERING Static and dynamic helicopter airframe analysis with MASTRAN N74-14616 STRUCTURAL REMBERS The testing of jet engines, chapters 5 and 6 test stand structure [AD-768492] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] Structural analysis of light aircraft using NASTRAN N74-14594
STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CHACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STRESS RATIO The use of fully stressed iteration and structural index in automated structural optimization A74-16477 STRUCTURAL ANALYSIS Effects of Ti-6Al-4v alloy metallurgical structures on ultrasonic response characteristics	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINERRING Static and dynamic helicopter airframe analysis with NASTRAN STBUCTURAL ENGINERRING STBUCTURAL ENGINERRING The testing of jet engines, Chapters 5 and 6 test stand structure [AD-768492] STRUCTURAL STRBILITY Bestraint procedures for cargo loaded in vehicles to be air transported [AD-768172] Structural analysis of light aircraft using NASTRAN N74-14594 Section 3: Stability, construction materials,
STRELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation A74-16600 Practure mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STRESS BATIO The use of fully stressed iteration and structural index in automated structural optimization A74-17739 STRUCTURAL AMALYSIS Effects of Ti-6Al-4v alloy metallurgical structures on ultrasonic response characteristics A74-18664	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation [AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL REGIMERING Static and dynamic helicopter airframe analysis with MASTRAN N74-14616 STRUCTURAL REMBERS The testing of jet engines, chapters 5 and 6 test stand structure [AD-768492] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] Structural analysis of light aircraft using NASTRAN N74-14594
STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STRESS CORROSION CHACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STRESS BATIO The use of fully stressed iteration and structural index in automated structural optimization A74-16407 STRUCTURAL ANALYSIS Effects of Ti-6Al-4v alloy metallurgical structures on ultrasonic response characteristics A74-16477 Structural analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] Structural analysis of light aircraft using RASTRAN [AIAA PAPER 74-257]	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CHITERIA Ottlity analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with NASTRAN N74-14616 STRUCTURAL ENGINEERIS The testing of let engines, chapters 5 and 6 test stand structure (AD-768492) STRUCTURAL STRBILITY Restraint procedures for cargo loaded in vehicles to be air transported (AD-768472) Structural analysis of light aircraft using NASTRAN N74-13954 Section 3: Stability, construction materials, construction methods
STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAN PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STEENS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] STEBUCTURAL ANALYSIS Effects of Ti-6Al-4v alloy metallurgical structures on ultrasonic response characteristics A74-16477 Structural analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] STRUCTURAL analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] STRUCTURAL analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] STRUCTURAL analysis of light aircraft using RASTRAN [AIAA PAPER 74-257]	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control A74-17740 The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with HASTRAN N74-14616 STRUCTUBAL MEMBERS The testing of jet engines, chapters 5 and 6 test stand structure [AD-768492] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] STRUCTUBAL STABILITY, construction materials, construction methods N74-14670 STRUCTUBAL STRAIF An improved exceedance theory for combined random
STEELS Aircraft components from remelted steels - Design and development A74-17887 STEATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAA PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STEESS CORROSION CHACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAA PAPER 74-230] STEESS RATIO The use of fully stressed iteration and structural index in automated structural optimization A74-16600 STRUCTURAL ANALYSIS Effects of Ti-6A1-4v alloy metallurgical structures on ultrasonic response characteristics A74-16477 Structural analysis of light aircraft using NASTRAN [AIAA PAPER 74-257] ATA-18664 Structural analysis of light aircraft using NASTRAN NATA-18664 STRUCTURAL ANALYSIS of light aircraft using NASTRAN NATA-18664	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Otility analysis in weight control The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706) Study of structural criteria for composite airframes, Volume 2: Current/criteria/selected rationale review and evaluation (AD-767707) Similarity requirements for aeroelastic models of helicopter rotors (ARC-CP-1245) STRUCTURAL REGIMERING Static and dynamic helicopter airframe analysis with MASTRAN N74-14616 STRUCTURAL REMBERS The testing of jet engines, chapters 5 and 6 test stand structure (AD-768492) STRUCTURAL STRBILITY Restraint procedures for cargo loaded in vehicles to be air transported (AD-768172) Structural analysis of light aircraft using NASTRAN N74-14594 Section 3: Stability, construction materials, construction methods N74-1467C STRUCTURAL STRBIM An improved exceedance theory for combined random stresses with application to aircraft qust
STEELS Aircraft components from remelted steels - Design and development A74-17887 STRATOSPHERE Temperature, winds, and turbulence at SST flight levels A74-17311 Stratosphere contamination by aircraft and mathematical models A74-17312 Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAN PAPER 74-42] Effect of supersonic transport upon the ozone layer, studied in a two-dimensional photochemical model with transport STEENS CORROSION CRACKING Hot-salt stress-corrosion of titanium alloys as related to turbine engine operation Fracture mechanics /Dryden Lecture/ aerospace structural design applications [AIAN PAPER 74-230] STEBUCTURAL ANALYSIS Effects of Ti-6Al-4v alloy metallurgical structures on ultrasonic response characteristics A74-16477 Structural analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] STRUCTURAL analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] STRUCTURAL analysis of light aircraft using RASTRAN [AIAA PAPER 74-257] STRUCTURAL analysis of light aircraft using RASTRAN [AIAA PAPER 74-257]	Optimisation of aircraft structures with multiple stiffness requirements N74-15612 Optimization and design of the rear fuselage of the A 300 B aircraft structure N74-15614 STRUCTURAL DESIGN CRITERIA Utility analysis in weight control A74-17740 The problem of optimal design of qas-turbine engines A74-18083 Study of structural criteria for composite airframes, Volume 1: Evaluation (AD-767706] Study of structural criteria for composite airframes. Volume 2: Current/criteria/selected rationale review and evaluation [AD-767707] Similarity requirements for aeroelastic models of helicopter rotors [ARC-CP-1245] STRUCTURAL ENGINEERING Static and dynamic helicopter airframe analysis with HASTRAN N74-14616 STRUCTUBAL MEMBERS The testing of jet engines, chapters 5 and 6 test stand structure [AD-768492] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] STRUCTUBAL STABILITY Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] STRUCTUBAL STABILITY, construction materials, construction methods N74-14670 STRUCTUBAL STRAIF An improved exceedance theory for combined random

STRUCTURAL VIBRATION SUBJECT INDEX

STRUCTURAL VIBRATION A study of the combined vibrations of the		SUPBRSONIC AIRCRAFT Transonic transport wings - Oblique or swept
disk-blade system of a turboprop engine	turbine	174-17048
wheel	A74-18088	SOPERSONIC BOUNDARY LAYERS A method of designing supercritical lift profiles
Control of an elastic aircraft	A74-18271	[DGLR PAPER 73-081] A74-17187 SUPERSONIC COMBUSTION RANJET ENGINES
Calculation of the dynamic characteristics helicopter structure by the method of by		The jet engine design that can drastically reduce oxides of mitrogen
Analysis of three-dimensional unsteady flo	A74-18291	[AIAA PAPER 74-160] A74-18797
oscillating wings	w around	SUPERSONIC COMPRESSORS Supersonic compressor test facility
[AIAA PAPER 74-184]	A74-18838	A74-18603
STRUCTURAL WEIGHT		SUPERSONIC FLIGHT
Manufacturing exercise involved in the red the Hawker Siddeley Trident /tri-jet/ fu	selage	On the problem of rain erosion on a moving body flying at supersonic speed
B-1 cost/weight trade methodology	A74-16445	174-16727 Temperature, winds, and turbulence at SST flight
	A74-16447	levels
Titanium - The bridge to composites fo weight/high performance aircraft	or light	SUPERSONIC PLOS
weightymigh periormance afficialt	a74-16451	Supersonic flow past sharp- and blunt-nosed
Buckling loads and minimum weight of comprourved ribbed aluminum alloy panels		conical bodies at angles of attack from 0 to 45
	A74-16822	[DGLR PAPER 73-080] A74-17186
An approach toward optimizing material cos	t and	Experimental study of the internal noise in
part function in advanced powerplants [SAE PAPER 730909]	174 47575	injector driven wind tunnels
Utility analysis in weight control	A74-17535	[ONERA, TP NO. 1315] A74-18288 Some specific characteristics of small gas
	A74-17740	turbines and the modeling problems of their wind
Suitability of using titanium pipelines in	the	tunnel testing
hydraulic systems of turbine engines		A74-18682
Determination of the basic parameters of 1	A74-18090	Application of an improved unified
helicopters on the basis of the treatmen	.igut itand	subsonic-supersonic potential flow method for the aerodynamic analysis of aircraft
analysis of statistical data		configurations
<u></u>	A74-18694	(AIAA PAPER 74-186) A74-18841
SUBSONIC AIRCRAPT Wing fuselage structural/concept study for	_	Theoretical investigation of supersonic flow past
subsonic transport aircraft	a	oscillating cascades with subsonic leading-edge
[SAE PAPER 730886]	A74-17533	[AIAA PAPER 74-14] A74-18843
Fixed wing aircraft		Three dimensional supersonic flow field analysis
Investigations concerning wing-furning	A74-18176	of the B-1 airplane by a finite difference
Investigations concerning wing-fuselage interference in the case of subsonic wel	ncity	technique and comparison with experimental data [AIAA PAPER 74-189] A74-18877
	A74-18897	On some basic and new aspects about the drag
SUBSONIC PLOW		problem of wings and bodies in supersonic flows
Calculation of separated flows at subsonic transonic speeds	and	N74-14713
cramsonic speeds	A74-16965	A study of the nonlinear aerodynamics of bodies in nonplanar motion numerical analysis of
Integral equation method for calculation o	f	aerodynamic force and moment systems during
subsonic flow past airfoils in a ventila		large amplitude, arbitrary motions
tunnel - Comparison with NAE high Reynol number measurements	ds	[NASA-TR-R-421] N74-14741
[AIAA PAPER 74-83]	A74-18764	Analysis of the flow about delta wings with leading edge separation at supersonic speeds
Application of an improved unified		[NASA-CR-132358] N74-14745
subsonic-supersonic potential flow metho	d for	SUPERSONIC INLETS
the aerodynamic analysis of aircraft configurations		Problem of adapting an intake to a turbojet engine
[AIAA PAPER 74-186]	A74-18841	for extremely high flight Mach numbers A74-17272
SUBSORIC PLUTTER		SUPERSONIC TRANSPORTS
A direct method for calculating flutter sp [AIAA PAPER 74-27]		Pixed wing aircraft
SUBSONIC SPRED	A74-18675	Aviation fuels and lubricants
Calculation of the aerodynamic characteris	tics of	A74-18180
a wing system moving at subsonic speed n or smooth water surface	ear land	Reduction of NO formations by premixing N74-14272
	174-18681	Effect of supersonic transport upon the ozone
A survey of drag prediction techniques app to subsonic and transonic aircraft design	licable D	layer, studied in a two-dimensional photochemical model with transport
·	874-14711	H74-14278
SUBSONIC WIND TUNNELS Integral equation method for calculation o	£	SUPERSONIC WAKES
subsonic flow past airfoils in a wentila	ted wind	Indestion and dispersion of engine exhaust products by trailing vortices for supersonic
tunnel - Comparison with NAE high Reynol	ds	flight in the stratosphere
number measurements [AIAA PAPER 74-83]	17h-4076*	[AIAA PAPER 74-42] A74-18815
SUPERCRITICAL PLOW	A74-18764	SURFACE COOLING Fetimation and optimization of the file cooling
A method of designing supercritical lift p	rofiles	Estimation and optimization of the film cooling requirements in a gas turbine combustion chamber
[DGLR PAPER 73-091]	A74-17187	[CRAMFIELD-SME-5] R74-14439
SUPERCRITICAL WINGS Aerodynamic Drag		SURPACE PINISHING
[AGARD-CP-124]	N74-14709	Design and development support for critical helicopter applications in Ti-681-4V allow
Drag of Supercritical airfoils in transonic	c flow	deficonter applications in T1-641-44 allow
comparison with conventional airfoil coefficients	draq	An aircraft exterior coating system and surface
COGITICIENCS	N74-14719	pretreatment

A74-18648

guan			
SURPACE LAYERS Nondestructive detection of hydrides and		Ţ	
alpha-case in titanium alloys		- 4.** 05051095	
	-16482	T TAIL SURFACES Lifting-surface theory for an oscillating T	-tail
SUPPACE VEHICLES Restraint procedures for cargo loaded in webic	:les		X74-17012
to be air transported		Measurements of rolling moments acting on t stabilizer of T-tails oscillating in yaw	be
[AD-768172] N/4 SURFACES	-13954	[NAL-TR-324]	N74-14744
On the modes of icing of symmetrical lifting	•	TAIL ASSEMBLIES	a.e. a.e.e
surfaces		Trinmed drag and maximum flight efficiency tail and canard configurations	OI AIT
SWEPT WINGS	-18987	[AIAA PAPER 74-69]	A74-18013
Relaxation methods for transonic flow about		Development of a graphite horizontal stabil	izer o load
wing-cylinder combinations and lifting swept	: wings i-16951	structural analysis of static ultimat and simulated fatique spectrum loading	e roud
Transonic transport wings - Oblique or swept	, ,0,5,	[AD-768869]	N74-14763
<u>a</u> 74	I-1704B	TAKBOFF Evaluation of aircraft departure divergence	
Influence of boundary layer blowing on the low-speed aerodynamic performance of a 45 de	eqree	criteria with a six-degree-of-freedom dig	ital
swept-wing airplane		simulation program	174-18882
[ATAM PAPER 74-269] A74 Calculation of the induced velocity field on a	1-18674	[AIAA PAPER 74-68] TARGET ACQUISITION	A74-10002
off the wing plane for a swept wing with giv		Lasers - Ranger and marked target seeker	
load distribution			A74-16756
[ARC-R/M-3725] N74 SYSTEMS ANALYSIS	i-14766	TARGET RECOGNITION Empirical assessment of ATCRBS performa	nce of
Plight study of a vehicle operational status a	ind	air traffic control digital processing sy	
monitoring system applied to systems on		[ATC-16], TECHNOLOGICAL FORECASTING	#14-13373
YF-12 aircraft [NASA-TN-D-7546] N74	¥- 13725	Noise and emission outlook for military enq	ines
Microwave Landing System (MLS) development pla	in as	[ATAR PAPER 73-1156] Future mir traffic control - Ground, cockpi	174-17175
proposed by AIL during the technique analysi and contract definition phase of the nationa		space system functions transfer to ai	rcraft
MLS development program. Part 1.0, Volume 1		or satellites	
Technique analysis program	4-14340	[AIAA PAPER .74-262] TECHNOLOGY ASSESSMENT	A74-18669
[FAA-RD-73-166-VOL-1.1] N74 Microwave Landing System (MLS) development pla		Avionics design for maintainability - Are w	e
proposed by AIL during the technique analysi	is	qaining or losing	A74-17531
and contract definition phase of the nationa MLS development program. Part 1.0, Volume 1		[SAE PAPER 730882] Heavy Lift Helicopter main engines	11.4 11.221
Book 1: Post TACD development plan		(SAE PAPER 730920)	A74-17537
[FAA-BD-73-166-VOL-1.2,1-BR-1] N74 Microwave Landing System (BLS) development pla	¥-14341 an as	Innovations in ATC communication systems ~= 1920's	- SINCE
proposed by AIL during the technique analysi	Ls		A74-17984
and contract definition phase of the nationa HLS development program. Part 3.0, Volume 3		Some current problems and prospects for development of rotary-wing aircraft	
Book 1: Compilation of critical technical a			A74-18641
reports	0-40303	The refining of turbipe fuels by modern hydrotreating	
[FAA-RD-73-166-VOL-3,1,1-BK-1] N74 Microwave Landing System (NLS) development pla	4-14343 an as	[AIAA PAPER 74-162]	A74-18798
proposed by AIL during the technique analysi	is	Practure mechanics /Dryden Lecture/ aer	ospace
and contract definition phase of the nationa MLS development program. Part 3.0, Volume 3		structural design applications [AIAA PAPER 74-230]	A74-18858
Book 2: Compilation of critical technical a		TECHNOLOGY UTILIZATION	#151
reports [FAA-RD-73-166-VOL-3.1,2-BK-2] N74	4-14344	Putting all our noise technology to work •• Quiet Engine Program	- NESA
SYSTEMS ENGINEERING			A74-17049
A self-reorganizing digital flight control sys	stem	Military and aerospace cost effective technology utilization for ATC, NASA proc	reams
for aircraft [AIRA PAPER 74-21] A74	4-18808	and defense projects	
The design and flight evaluation of a performa		TEMPERATURE DISTRIBUTION	A74-18050
control system general aviation aircraft under VFR conditions	L	Evaluation of the influence of errors in	
fan-7677861 N74	4-13746	specifying boundary conditions on the acc	uracy '
Bicrowave Landing System (BLS) development plant proposed by AIL during the technique analysis	an as is	of the determination of temperature field infinite cylinders	12 11
and contract definition phase of the nations	al	·	A74-18635
MLS development program. Part 1.0, Volume 1 Book 2: Post TACD development plan	1, 2,	TEMPERATURE RFFECTS Ingestion and dispersion of engine exhaust	
[PAA-RD-73-166-VOL-1, 2, 2-BK-2] N7	4-14342	products by trailing vortices for superso	onic
Microwave Landing System (MLS) development pla	an as	flight in the stratosphere [AIAA PAPER 74-42]	A74-18815
proposed by Raytheon during the technique analysis and contract definition phase of the	he	TEMPERATURE MEASUREMENT	M14 10013
national MLS development program. Volume 4:		A film thermocouple with a platinum electro	de for
System considerations 1.1.2 through 1.1.5 [PAA-RD-73-150-4] 87	9-153B4	thermometry of das turbine endine blades	A74-18686
Microwave Landing System (MLS) development pla		TEMPERATURE SENSORS	
proposed by Raytheon during the technique analysis and contract definition phase of the	he	Beat transfer investigation in a high-temporal gas flow spreading over a plane surface	erature
national MLS development program, Volume 6:		•	A74-18684
Supporting studies, appendices D through W		TRUSILE STRENGTH Development of cold headable titanium allow	es for
(FAA-RD-73-15C-6-APP-D-N) N75	4-15386	Development of cold headable titanium allow the 'Concorde' supersonic jet	
The effect of inlet distortion on the perform	ance	•	A74-16554
and stability of the low-speed spool of a turbofan engine		TRESILE TESTS Experimental study of metal-plastic coupling	ngs in
	4-18855	tension	

SUBJECT INDEX

TERMINAL PACILITIES	Concepts for a theoretical and experimental study.
Electronic displays and digital automatic control	of lifting rotor random loads and wibrations
in advanced terminal area operations	(the effects of some rotor feedback systems on
[AIAA PAPER 74-27] A74-188 Field evaluation of ARTS 2 B (TRACAB)	881 rotor-body dynamics), Phase 7-A [NASA-CR-114709] N74-14757
evaluation of radar beacon for air traffic	TITANION ALLOYS
control applications	Manufacturing exercise involved in the redesign of
[AD-768203] N74-143	
Simplified Visual Approach Slope Indicator (VASI)	A74-16445
operation test and evaluation	The use of ultra high strength titabium alloys in
[AD-767901] N74-143	
TEST EQUIPMENT Flight study of a vehicle operational status and	5. A. Harrier
monitoring system applied to systems on	B-1 cost/weight trade methodology
YP-12 aircraft	174-16447
[NASA-TN-D-7546] N74-137	
Ground operation tests of flying test bed for VTO	helicopter applications in Ti-6A1-4V alloy
aircraft at National Aerospace Laboratory	A74-16448
[NAL-TR-319] N74-147 TEST FACILITIES	
Supersonic compressor test facility	application
A74-186	A74-16449 303 Applications of the high strength alloy
Pollution control of airport engine test facilities	
N74-142	
TEST STANDS	Titanium - The bridge to composites for light
The testing of jet engines, chapters 5 and 6	weight/high performance aircraft
test stand structure	A74-16451
[AD-768492] N74-154 THERHAL COMPORT	
Utility analysis in weight control	in titanium components A79-16476
A74-177	
THEBBAL CYCLING TESTS	structures on ultrasonic response characteristics
Hot-salt stress-corrosion of titanium alloys as	A74-16477
related to turbine engine operation	Ultrasonic inspection of titanium airframe
THERMAL STRESSES	
Transmission thermal mapping (CH-47C forward rotor	Non-deptanching increation of hiteria delication
transmission)	Non-destructive inspection of titanium jet engine disks
FAD-767875] N74-137	
THRRHOCHEMICAL PROPERTIES	Nondestructive detection of hydrides and
Ablation heat and mass transfer in hypersonic	alpha-case in titanium alloys
flight	A74-16482
THERNOCOUPLES A74-171	
A film thermocouple with a platinum electrode for	aircraft application
thermometry of gas turbine engine blades	A74-16513 Development of cold headable titanium alloys for
A74-186	the 'Concorde' supersonic jet
THICKNESS	174-16554
Airborne profiling of ice thickness using a short	Deep hardenable titanium alloys for large airframe
pulse radar	elements
THIN AIRFOILS	417 10007
Thin-airfoil theory of an ejector-flapped wing	Dynamic creep of titanium alloy with 1.5 wt % Mn and 3% Al in high-velocity air streams
section	174-16579
[AIAA PAPER 74-187] A74-188	34 Fretting resistant coatings for titanium alloys
THIB WALLED SHELLS	A74-16592
An algorithm for rational selection of the	Bot-salt stress-corrosion of titanium alloys as
parameters of nonlinearly deforming thin-walled framework elements	related to turbine engine operation
A74-186	A74-16600
THREE DIMENSIONAL BOUNDARY LAYER	45 Titanium flamecutting reduces airframe costs A74-16760
Three-dimensional compressible boundary layer flow	Beat-resistant titanium alloys - Introduction of
over a vawed come with mass injection	the 651 A alloy
774-139	50 a7u=17891
THERE DIMENSIONAL FLOW	Suitability of using titanium pipelines in the
Analysis of three-dimensional unsteady flow around oscillating wings	hydraulic systems of turbine engines
[AIAA PAPER 74-184] A74-188	38 TOUCH \$74-18090
Three dimensional supersonic flow field analysis	Tactile display for aircraft control
of the B-1 airplane by a finite difference	[AD-767763] N74-13741
technique and comparison with experimental data	TOWED BODIES
[AIAA PAPER 74-189] A74-188	-,
THRUST VECTOR CONTROL STOL tactical aircraft investigation, Volume 2:	wheel for stability
Design compendium	A74-18141
[AD-767561] N74-137	A preliminary design of a remotely-controlled glider for a long-line operation
STOL tactical aircraft investigation. Volume 5:	(AD-767879) N74-13744
Flight control technology	Performance of a ballute decelerator towed behind
[AD-767364] 874-137	35 a jet airplane
TILTING ROTORS	[NASA-TM-I-56019] N74-14760
Y/STOL tilt rotor aircraft study. Volume 10: Performance and stability test of A 1-14,622	TRAILING EDGES
Proude scaled Boeing Vertol Hodel 222 tilt rotor	New investigations for reducing the base drag of
aircraft (Phase 1)	wings with a blunt trailing edge effects of splitter plates and splitter wedges on
FNASA-CR-1146037 N74-137	27 aerodynamic drag coefficients
	N74-14723

SUBJECT INDEX TURBOJET ENGINES

TRAILING-EDGE FLAPS	Computer program to perform cost and weight
The jet-flapped wing in ground proximity with	analysis of transport aircraft, Volume 1;
special allowance for large angle of attack and	Summary [NASA-CR-132361] H74-14762
large det flap angle A74-17221	Computer program to perform cost and weight
TRAINING AIRCRAPT	analysis of transport aircraft. Volume 2:
The Alpha Jet programme	Technical volume r wasa-cp-1323623 N74-14763
A74-18902	[NASA-CR-132362] N/4-14/65 TURBINE BLADES
TRAJECTORY AMALYSIS Decoupling of a class of nonlinear systems and its	A study of the damageability of turbine blades of
application to an aircraft control problem	aircraft qas-turbine engines after operational
A74-18139	running in A74-18085
TRANSPER FUNCTIONS	A study of the combined vibrations of the
Analysis and calculation of lightning-induced voltages in aircraft electrical circuits	disk-blade system of a turboprop engine turbine
[NASA-CR-2349] N74-14754	wheel
TRANSONIC FLIGHT	A74-18088 A film thermocouple with a platinum electrode for
Transonic transport wings - Oblique or swept A74-17048	thermometry of gas turbine engine blades
TRANSONIC FLOW	a74-18686
Relaxation methods for transonic flow about	Life of fatique cracks on rotor blades of turbines
wing-cylinder combinations and lifting swept wings	in qas turbine engines (AD-767947) N74-14447
A74-16951 A direct method for computing the steady flow at	Blade dynamics analysis using WASTRAN effects
Each number one past a given wing airfoil	of blade geometry, temperature gradients, and
A74-16963	rotational speed
Calculation of separated flows at subsonic and	N74-14599
transonic speeds A74-16965	TURBINE ENGINES 1700 aims at low combat maintenance turboshaft
Development of a method of	engine for military transports and helicopters
discretized-distribution singularities for the	a74-18998
study of compressible and incompressible flows	TORBINE WREELS
A74-16968 A relaxation method for calculating transonic	Status of the latest turbine disk alloys in the U.S A74-17890
flows with detached bow shocks	A study of the combined wibrations of the
A74-16970	disk-blade system of a turboprop engine turbine
A method of designing supercritical lift profiles	wheel A74-18388
[DGLR PAPER 73-081] A74-17187 Transonic flow about lifting wing-body combinations	TORBOCOMPRESSORS
[AIAA PAPER 74-185] A74-18812	The effect of inlet distortion on the performance
Similarity parameters and their sensitivity for	and stability of the low-speed spool of a
transonic airframe exhaust nozzle interactions	turbofan engine [AIAA PAPER 74-234] A74-18855
[AD-768988] H74-14746 TRANSORIC SPEED	The unsteady circulation distribution in rotors
Transonic single-mode flutter and buffet of a low	and its application to noise studies
aspect ratio wing having a subsonic airfoil shape	974-14437
[NASA-TN-D-7346] N74-14631 A survey of drag prediction techniques applicable	TURBOFAN ENGINES The effect of inlet distortion on the performance
to subsonic and transonic aircraft design	and stability of the low-speed spool of a
N74-14711	turbofan engine
HFL-10 lifting body flight control system	[AIAA PAPER 74-234] A74-18855
characteristics and operational experience [MASA-TH-X-2956] #74-14753	Developmental design, fabrication, and test of acoustic suppressors for fans of high bypass
TRANSONIC WIND TUBBELS	turbofan engines
Experimental study of the internal noise in	[NASA-CR-2338] N74-13724
injector driven wind tunnels FONERA, TP NO. 13151 A74-18288	TURBOJET ENGINES Problem of adapting an intake to a turbojet engine
[ONERA, TP NO. 1315] A74-18288 TRANSPORT AIRCRAFT	for extremely high flight Bach numbers
Wing fuselage structural/concept study for a	A74-17272
subsonic transport aircraft	Emission of gaseous pollutants by turbojet engines
[SAR PAPER 730886] A74-17533	- The Olympus case
Vehicle crashworthiness rotary wing, fixed wing light and transport aircraft	Particle sampling and size analysis in the
A74-17776	ejection zone of the Olympus jet engine at
Rotary-wing aircraft	ground level
174-18177 T700 aims at low combat maintenance turboshaft	A74-17306 Evolution of applications of precision casting in
engine for military transports and helicopters	turbojets
A74-18998	174-17892
Performance characteristics of short haul	Propulsion system installations for aircraft A74-18179
transport aircraft intended to operate from reduced length runways	Noise generation by cylindrical spoilers immersed
[CRANFIELD-AERO-18] N74-13716	in an air duct analysis of acoustic power
The influence of wing loading on turbofan powered	output and directivity patterns of noise field
STOL transports with and without externally blown flaps	[AD-767336] 874-13730 Turbojet aircraft engine test cell pollution
(NASA-CB-2320) N74-13718	abatement study
Wind tunnel investigation of a large-scale 25 deg	[AD-768287] N74-13957
swept-wing jet transport model with an external	Reduction of NO formations by premixing N74-14272
blowing triple-slotted flap [NASA-TM-X-62197] N74-13721	N/4-142/2 Sonic inlet noise attenuation and performance with
Minimum life cycle costing for a Y/STOL transport	a J-85 turbojet engine as a noise source
(AD-768133) N74-13740	[MASA-TM-X-71488] N74-14384
Economics of air transport direct and indirect	The effect of water injection on mitric oxide emissions of a gas turbine combustor burning
costs [NASA-TT-F-15249] 874-14682	ASTE Jet-A fuel
The problem of installing a modern high bypass	[HASA-TM-X-2958] N74-14650
engine on a twin jet transport aircraft	•
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	

TUBBONACHIMERY SUBJECT INDEX

Effect of water injection on mitric oxide		UESTEADY FLOW
emissions of a gas turbine combustor burning	q	Unsteady lift forces on highly cambered airfoils
natural gas fuel [NASA-TH-X-2959] N74	4-14651	moving through a qust [AIAA PAPER 74-88] A74-18807
TURBONACHINERY		Analysis of three-dimensional unsteady flow around
Erosion prediction in turbomachinery due to		oscillating wings
environmental solid particles	4-18732	[AIAA PAPER 74-184] A74-18838 The unsteady circulation distribution in rotors
[AIAA PAPER 74-16] A74 The spectrum of turbomachine rotor noise cause		and its application to noise studies
inlet quide vane wakes and atmospheric turbu		H74-14437
	4-14379	USER HANUALS (COMPUTER PROGRAMS)
TURBOPROP ENGINES A study of the combined wibrations of the		Plotting program for aerodynamic lifting surface theory user manual for FORTRAN computer
disk-blade system of a turboprop engine turb	bine	program
wheel		[NASA-TH-X-62321] N74-14739
TURBOSHAPTS	4-18088	OTILITY AIRCRAFT Structural analysis of light aircraft using MASTRAN
The T700-GE-700 turboshaft engine program		в74-14594
•	4-17536	
TURBULENCE EFFECTS Jet noise modeling - Experimental study and mo	odole	V
for the noise and turbulence fields	ouers	V/STOL AIRCRAFT
(AIRA PAPER 74-3) A74	4-18723	The use of ultra high strength titanium alloys in
TURBULENT BOUNDARY LAYER	_	a V/STOL military aircraft application - The H. S. A. Harrier
Abalysis of flow-reversal delay for a pitching airfoil	4	3. A. Hailler A74-16446
	4-18835	Barch 1971 wind tunnel tests of the Dorand DH 2011
Measurements of the drag of some characteristi		jet flap rotor, volume 1 [NASA-CR-114693] N74-13722
aircraft excrescences immersed in turbulent boundary layers		[NASA-CR-114693] N74-13722 V/STOL tilt rotor aircraft study. Volume 10:
	4-14714	Performance and stability test of A 1-14.622
TORBULENT DIFFUSION		Froude scaled Boeing Vertol Model 222 tilt rotor
Stratosphere contamination by aircraft and mathematical models		aircraft (Phase 1) [NASA-CR-114603] N74-13727
	4-17312	Minimum life cycle costing for a V/STOL transport
TUBBULENT PLOW		[AD-768133] X74-13740
Noise from nonuniform turbulent flows	4-18722	VACUUM MELTING Aircraft components from remelted steels - Design
[ATAA PAPER 74-2] A74 Representation of hot jet turbulence by means		and development
its infrared e∎ission		A74-17887
	4-14383	VARIABLE HASS SYSTEMS
TURBULENT WAKES Characteristics of the wake behind a cascade of	of	Fonstationary vibrations of a rigidly supported flexible rotor of variable mass
airfoils		A74-17851
Vortex cases - At a turbulent crossroads	4-17495	VEHICLE WHERLS The flow field and pressure distribution of an
aircraft wakes and legal liability for accid	dents	isolated road wheel
A78	4-18097	[IC-AERO-72-14] N74-14706
Vortex age as a wake turbulence scaling parame [AIAA PAPER 74-36] A74	eter 4-18745	VELOCITY DISTRIBUTION Vortex age as a wake turbulence scaling parameter
Comparison of various methods for calculating		[AIAA PAPER 74-36] A74-18745
profile drag from pressure measurements in t		A method of calculating aircraft wake velocity
near wake at subcritical speeds		profiles and comparison with full-scale
TURNING PLIGHT	4-14721	experimental measurements [AIAA PAPER 74-39] A74-18747
Differential-turning optimality criteria i	for	Calculation of the induced velocity field on and
aircraft pursuit/evasion situations		off the wing plane for a swept wing with given
[AIAA PAPER 74-23] A74	4-18737	load distribution [ARC-B/B-3725] 874-14766
Integral equation method for calculation of		VELOCITY HEASUREMENT
subsonic flow past airfoils in a ventilated	wind	A direct method for calculating flutter speeds
tunnel - Comparison with NAE high Reynolds number measurements		[AIAA PAPER 74-27] A74-18675 Aircraft velocity measurement through
[AIAA PAPER 74-83] A74	4-18764	radar-altimeter echo: A theoretical investigation
Comparison of various methods for calculating		[SLa-73-669] N74-14119
profile drag from pressure measurements in t near wake at subcritical speeds	the	VERTICAL TAKEOFF AIRCRAFT Vertical take-off and landing aircraft
	4-14721	A74-18178
THO STAGE TORDINES		Ground operation tests of flying test bed for VTOL
The T700-GB-700 turboshaft engine program (SAE PAPER 730917) A74	4-17536	aircraft at National Aerospace Laboratory [WAL-TR-319] #74-14764
Commence caases and a second	. 17550	VERTIGO RATE TRANSPORT
U		Orientation-error accidents in regular Army UH-1
UH-1 HELICOPTER		aircraft during fiscal year 1970: Relative incidence and cost
Hador Item Special Study (MISS), AR-16 mast as	ssembly	[AD-768307] H74-13742
failure analysis of helicopter antenna :		VEF CHRIBANGE WAVIGATION
assembly (AD-768764) #74	4-14762	The impact of area navigation on flight control
ULTRASONIC TESTS	T- 14/0Z	systems and displays
Effects of Ti-611-47 alloy metallurgical		VIBRATION
structures on ultrasonic response character		Blade dynamics analysis using BASTRAB effects
Ultrasonic inspection of titanium airframe	4-16477	of blade geometry, temperature gradients, and rotational speed
components		. #74-14599
Nondestructive detection of hydrides and	4-16479	
alpha-case in titanium alloys		

174-16482

IBRATION DAMPING		Effect of water injection on mitric oxide	ina
Reduction of wibration and noise generated by		emissions of a gas turbine combustor burn	TDA
planetary ring gears in helicopter aircraft		natural das fuel	#74-14651
transmissions		(WASA-TH-X-2959]	B14-14031
[ASME PAPER 73-PTG-11] A74-1	6979 98	APON SYSTEMS Two numerical methods to solve realistic	
A study of the combined vibrations of the		air-to-air combat differential games	
disk-blade system of a turboprop engine turbin	e	(AIAA PAPER 74-22)	A74-18736
wheel	0000 07	AR TESTS	
174-1	9000 MT	Pralmation of methods for reducing fretting	7
Random wibration with non-linear damping A74-1	6207	fatique damage in 2024-T3 aluminum lap io	oints
Methods for reducing vibrations of equipment	0231		174-16696
mounted on belicopter external stores stations	. WE	ATEER HODIFICATION	
damping of vertical vibrations of		Thermal and chemical for dissipation: Resu	ilts of
wing-mounted stores on AH-1G helicopter		field experiments at Vandenberg APB, Cali	LIOTNIA
[AD-768774] B74-1	4771	during July 1972	N74-15367
In-flight stabilization of externally slung		[AD-768671]	M14. 13301
helicopter loads design, development, and	WE	#IGHT AWALYSIS B-1 cost/weight trade methodology	
evaluation of candidate stabilizing systems		R-1 CORTABELDER FLUTE Bernogorod)	A74-16447
[AD-769063] N74-1	4//4	Otility analysis in weight control	
VIBRATION HODE		Occided and the contract of th	174-1774C
A study of the combined vibrations of the disk-blade system of a turboprop engine turbin		Computer program to perform cost and weight	ţ
wheel		analysis of transport aircraft. Volume	1:
Wheel A74-1	8808	Summary	
Calculation of the dynamic characteristics of a		[NASA-CR-132361]	N74-14762
helicopter structure by the method of branch	iodes	Computer program to perform cost and weight	t n.
. A74-1	18291	analysis of transport aircraft. Volume	2:
On repetitive flutter calculations in structural		Technical volume	N79-14763
design		[NASA-CR-132362]	M/4-14/03
[AIAA PAPER 74-141] A74-1	8789 WE	HEBL BRAKES Recent studies of tire braking performance	for
VISCOUS PLOW		aircraft	
Calculation of separated flows at subsonic and		allclair	A74-17898
transonic speeds	16065 91	HITE MOISE	
		Random wibration with non-linear damping	
The effects of hypersonic viscous interaction or static stability of slender bodies in simulate	-d	W4222 722472	174-18297
non-equilibrium flows	w)	IND RPPECTS	
N74-	14704	Multi-input, multi-output regulator design	for
VISUAL PERCEPTION		constant disturbances and non-zero set p	oints
Simplified Visual Approach Slope Indicator (VAS)	[)	with application to automatic landing in	a
operation test and evaluation		crosswind	N74-15378
[AD-767901] N74-	14362	[NASA-CR-136618]	014-13370
VORTEX BREAKDOWN	W:	IND MEASURERSHT	fliaht
Lift-induced wing-tip wortex attenuation	****	Temperature, winds, and turbulence at SST	
(8184 14175 14 90)	18852	levels	174-17311
VORTEI SHEETS	. 0'	IND TUNERL APPARATUS	
Numerical investigation of vortex sheets issuing from a separation line near the leading edge	•	Assessment of the influence of inlet and	
ALCH Sebalation line near the reading onde	18289	afthody/nozzle performance on total mirc	raft draq
VORTICES			74-14726
A vortex entrainment model applied to slender	W:	IND TOWNEL DRIVES	_
delta wings		Experimental study of the internal noise i	n
	17029	injector driven wind tunnels	A74-18288
Vortex cases - At a turbulent crossroads		[ONBRA, TP NO. 1315]	A74-10200
aircraft wakes and legal liability for accide	Bts W.	IND TURBEL EODELS Some specific characteristics of small ques	
	18097	turbines and the modeling problems of th	eir wind
vortex age as a wake turbulence scaling paramet	18745	tunnel testing	,
[AIAA PAPER 74-36] A74- A method of calculating aircraft wake velocity	10745		A74-18682
profiles and comparison with full-scale		V/STOL tilt rotor aircraft study. Volume	10:
experimental measurements		Performance and stability test of A 1-14	.622
[AIAA PAPER 74-39]	18747	Froude scaled Boeing Vertol Model 222 ti	lt rotor
Isolated airfoil - TIP worter interaction noise		aircraft (Phase 1)	man 40000
[AIAA PAPER 74-194] A74-	18831	[NASA-CR-114603]	N74-13727
·		STOL tactical aircraft investigation. Vol	.u#8 4:
W		Wind tunnel data analysis	N74-13734
• • • • • • • • • • • • • • • • • • • •		[AD-767363] IND TOWNEL TESTS	#177 12124
WARNING SYSTEMS	•	Wind tunnel dynamic analysis of an oscilla	tina
The Type 3B altitude measurement system	17276	airfoil	,
		(AIAA PAPER 74-259)	A74-18666
Airborne warning and control system /AWACS/ for air operations management during military		Forter age as a wake turbulence scaling pa	rameter
crises		[AIAA PAPER 74-36]	A74-18745
	18655	Aerodynamic forces and moments on a slende	r body
The design, fabrication and evaluation of the		with a jet plume for angles of attack up	to 180
aural angle of attack/stall warning system		degrees	47#_ #0777
[AD-767663] N74-	13748	[AIAA PAPER 74-110]	A74-18776
MATER EROSION		Isolated airfoil - TIP vortex interaction	174-18831
On the problem of rain erosion on a moving body		[AIAA PAPER 74-194] Preliminary wind tunnel noise measurements	
flying at supersonic speed	16727	Resi-span wing with an upper-surface blooms	own-flan
	10121	[AIAA PAPER 74-191]	174-18832
WHITE INJECTION The effect of water injection on nitric oxide		Investigations concerning wing-fuselage	2
the effect of water injection on mittle office emissions of a gas turbine combustor burning	•	interference in the case of subscnic well	Locity
ASTM Jet-A fuel	•		≜74~18897
[NASA-TH-X-2958] N74-	14650	Barch 1971 wind tunnel tests of the Dorand	1 DH 2011
where the state of		jet flap rotor, volume 1	
		[BASA-CB-114693]	H74-13722

ŀ	la	EC		197	71	wi	íná	1 t	un	ne	1 1	t es	ts	οf	the	Dog	and	DH	2011	
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7		ָא ז											-:-		si				4-14631	
•	**														die					
										10										
																			4-14704	
A															fet			iqai	cion	
		OI [NI						res	ss	11	I C	Lng	aı	ric	il i	10	1	w71	4-14708	
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	,_	oh!			-		4								. E		. 1 4		4-14714 	
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		BO								-		- 4 -								
												_							4-14715	
1						lra	pe	đτ	ıe	to	1:	ift	of	p1	anaı	r je	t-f	lapı	∍e₫	
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		F N										-					,	N74	4-14744	
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Ā	r	ti:	10	ia.	1	d€	5 A 6	elc	pa	en.	t c	of 	an	atm	ospl	heri	.c b	ound	lary	
		fla	v	D.C	di	ıla	e t	inc	. A	GA.	ico	9 L	at.	win	iner ig ti		1 05.	ing ntra	wind ance	
			-													21161			4-13701	
ING											_									
1		ın. sec				ιŢ	ti	ec	ΣY	0	E é	20	ere	cto	r-fl	Lapp	ed	wind	1	
		[A]				PE E	a.	74-	18	71								3.70	3-18B34	
2	T	OL	ti	ict	ic	:a]	l a	ii	cr	af	t i	inv	est	iqa	tio	ı, e	*te			
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		la: []						5										W7/	3-13755	
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		pro	נטי	.e.	ь	50) I (1.5.1	On									174	-17270	
A		ne t	h	đ	of	i c	al	Lou	la	ti	ng	ai	rcr	aft	wal	e v	elo			
		pro	fi	16	25	ап	ıd	CC	a p	ar:	isc	n	wit	h f	u11-	sca	le	•		
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P		[A] EC6									c z	IT P	t =	nā	del4	A 14	i na-	a/4	1-1874 7	
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		(A I						57										NŽ	-14766	
IBG									4 -	_			ı							
*		nd aim				. а	1 Y E	ı a B	ııc	aı	ual	L Y S	15	OÍ	an c	sci	TIA	cinq	I	
		(A)	λ	P	AF													A70	-18666	
À	n	alı	si	s	οf	t	Ьı	ee	-d	i n	ens	i0	bal	un	stea	ıdy	flo	ar	ound	
		OS(4500-	
ING								-	18	4 1								¥74	-18838	
A	L	aet	: hc	d	οf		:a1	Cu	la	t1	ρđ	ŧЬ	e f	low	arc	und	a ı	rinc	of	
		arı	,,,	ra	ry	P)1a	nf	or	■,	рc	>si	tio	ned	on	a c	yli:	ndrj	cal	
		rod	Ţ																	
p		ے 1 1ء	. p. 4	n a	ıru	, 14	ı ji n	ıd	ŧ n	nn-	-1	nc.	ien		asur	-0=^	n+~	A74	1-18632	
-	'n			81	a	1 1	i	Pε	٧i	th	åл	נו נו ו	ppe	r-s	urfa	.ese ice	blo	JI 10-1	lap	
		sei	11-						-=			_				~				
		sei []			Α.	ĸ.		4-	19									A74	I-18832	
7	r	sei []] ans		ic	A	i	ı g J	(4- Le-	19	đe	£	ut	ter	an	đ bu	ıffe	t o	1.74 Ea	I-18832 low	
1	r	sei (A) ans asp	901	ic	A E	in iti	(/ ig]	e- e-	19 80 80	đe	f]	ut	ter	an	đ bu	ıffe	t o	174 E a Dil	1-18832 low shape	
	r	Sei Als Als Asi Ni	ec	ic t	I I	in ti	19]	e- wi	19 09 1	de ha	lVj	eq.	ter a	an sub	d bu soni	iffe ca	t of	174 E a Dil N74	I-18832 low shape I-14631	
	r	Sei (A) ans as; [N) v j	103 103 121 121 171	ic t -1	rat Ta	in ti D- qa	q] io ·7: iti	e- wi 06 bl	no ng j s	de ha for	r T	ed il	ter a uci inq	an sub nq ed	d busoni the	iffe ic a bas	t of	274 E a Dil N74	I-18832 low shape I-14631	
	r	Sel Als Ass Ass No Vis Vis Spl	SOL SOL SAL SAL SAL SAL SAL SAL SAL SAL SAL SA	ic t es	TA TA TA TA TA	in ti D- qa h	q] io 73 ti a	e- wi ob bl	no no no no no no no no no no no no no n	de ha for t i	r r sp	ed il	ter a uci inq	an sub nq ed	d bu soni	iffe ic a bas	t of	274 E a Dil N74	I-18832 low shape I-14631	

SUBJECT INDEX Plotting program for aerodynamic lifting surface theory --- user manual for FORTRAN computer program [NASA-TH-X-62321]. [NASA-TH-I-62321]. N74
Measurements of rolling moments acting on the stabilizer of I-tails oscillating in yaw [NAL-TR-324] N74
WING PROFILES Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept wings A74-16951 Transonic transport wings - Oblique or swept Calculation of the aerodynamic characteristics of a wing system moving at subsonic speed near land or smooth water surface WING TIPS Lift-induced wing-tip wortex attenuation [AIAA PAPER 74-38] RTNCS The jet-flapped wing in ground proximity with special allowance for large angle of attack and large jet flap angle Investigations concerning wing-fuselage interference in the case of subsonic velocity INVING MOMENTS with a jet plume for angles of attack up to 180 degrees [AIAA PAPER 74-110]

A74-18852

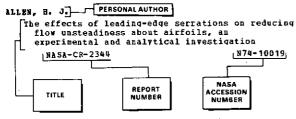
A74-18897

PERSONAL AUTHOR INDEX

AERONAUTICAL ENGINEERING / A Special Bibliography (Suppl. 43)

APRIL 1974

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The accession number is located beneath and to the right of the title, e.g., N74-10019. Under any one author's name the accession numbers are arranged in sequence with the IAA accession numbers appearing first.

Δ

AALSTENBERG, R.	
STOL tactical aircraft investigation, Volu	me 5:
Flight control technology	
[AD-767364]	N74-13735
AGNONE, A.	
The jet engine design that can drastically	reduce
oxides of mitrogen	174-18797
[AIAA PAPER 74-160]	Z74-10737
AHMED, S. R. Investigations concerning wing-fuselage	
interference in the case of subsonic velo	city
Intellerence In the great at a	A74-18897
AIREN, T. B.	
terodynamic and noise measurements on a Gui	si-two
dimensional augmentor wing model with lot	e-type
nozzles	
[NASA-TM-X-62237]	N74-13719
AKERS, J. P.	
Field evaluation of ARTS 2 B (TRACAB)	N74-14360
[AD-768293]	M/4-14300
ALEXANDER, B. R. V/STOL tilt rotor aircraft study. Volume	10 :
Performance and stability test of A 1-14	622
Proude scaled Boeing Vertol Model 222 ti	lt rotor
aircraft (Phase 1)	
[NASA-CR-114603]	N74-13727
MARRITIERE. E.	
pevelopment of cold headable titanium allo	ys for
the 'Concorde' supersonic jet	
	A74-16554
Drag of lifting bodies for pilots at high	al+i+udo
prad of fifting bodies for priors at midu	N74-14731
ALTHAN, H. G.	1.74 .472
STOL tactical aircraft investigation. Vol	ume 2:
Design compendium	
[AD-767561]	N74-13733
ALVAREZ, H, C.	
Economics of air transport	
[NASA-TT-F-15249]	N74-14682
ALVERMANN, W.	
Propulsion system installations	A74-18179
	8/4-101/3
Isolated airfoil - TIP vortex interaction	noise
[AILA PAPER 74-194]	A74-18831
ANDO, Y.	
Heasurements of rolling moments acting on	the
stabilizer of T-tails oscillating in yaw	
[NAL-TR-324]	N74-1474

AWDRES, J. New technologies and profitability of helic	
New technologies and profitability of helic	opters N74-13717
[NASA-TT-P-15195]	M14-13111
AMIRID, A. IA.	de for
A film thermocouple with a platinum electro thermometry of gas turbine engine blades	46 101
Chermometry of das carbine ending process	A74-18686
ABTOWATOS, P. P.	
issessment of the influence of inlet and	
aftbody/nozzle performance on total aircr	aft drag
	N74-14726
MOYAGI, K.	05.3
Wind tunnel investigation of a large-scale	25 ded
swept-wing jet transport model with an ex	ternal
blowing triple-slotted flap	N74-13721
[NASA-TH-X-62197]	11.4 13111
ASSEC, S. J. Decoupling of a class of nonlinear systems	and its
application to an aircraft control proble	D
apprioación do un arrela de la companya de la compa	A74-18139
ATASSI, E.	
Unsteady lift forces on highly cambered air moving through a gust	foils
moving through a gust	
[AIAA PAPER 74-88]	374-18807
ATRINS, B. R.	od erou
Definition of study objectives for integrat	ed Clew
module development	N74-14773
(AD-769065) AUBRUM, J.	
March 1971 wind tunnel tests of the Dorand	DH 2011
Harch 1971 wind tunnel tests of the Dorand jet flap rotor, volume 1	
[NASA-CR-114695]	M14-13166
March 1971 wind tunnel tests of the Dorand	DK 2011
jet flap motor, volume 2	
(NASA-CR-114694)	N74-13723
AUSTIN, A. L.	
The hydrogen fuel economy and aircraft prop	A74-17905
[AIAA PAPER 73-1319]	K/4-1/202
ATOUB, B. J. Transmission thermal mapping (CH-47C forward	d rotor
transmission)	
[AD-767875]	N74-13732
•	
В .	
BADGLEY, R. H.	h
Reduction of vibration and noise generated	υγ • f t
planetary ring gears in helicopter aircra	3.00
transmissions [ASME PAPER 73-PTG-11]	A74-16979
Recommended design modifications to the CH	
forward rotor drive gearbox	
[AD-769062]	N74-14775
BARR, D. W. Noise and emission outlook for military en	
Noise and emission outlook for military en	gines
[AIAA PAPER 73-1156]	A74-17175
Technology for the reduction of aircraft t	arbine
engine exhaust emissions	N74-14300
BAILEY, P. B.	M14-14301
Polaration methods for transonic flow about	t
Relaxation methods for transonic flow abou wing-cylinder combinations and lifting s	wept wings
	A74-16951
BAILY, D. L.	
Pollution control of airport engine test f	acilities
	N74-14285
BALLAL, D. R.	-14
Estimation and optimization of the film co	OLING OLING
requirements in a gas turbine combustion	слашвег N74-14439
[CRANFIELD-SME-5] A proposed method for calculating film-coo	
temperatures in que turbine combustion of	Lambara
	nambers

[CRANFIELD-SME-4]

BALLHAUS, W. P. Relaxation methods for transonic flow about wing-cylinder combinations and lifting swept w A74-1	BOGACHOV, I. H. Dynamic creep of titanium alloy with 1.5 wt % En ings and 3% Al in high-velocity air streams 474-16579
BARNUELL, B. W. Transonic flow about lifting wing-body combination	BOHANEK, E. Ons Deep hardenable titanium alloys for large airframe
FAIAA PAPER 74-1851 A74-1 BARON, R. S.	8812 elements - A74-16559
Performance of a ballute decelerator towed behing a jet airplane	A BORODIB, V. T. Flight control of airplanes and helicopters
[NASA-TM-X-56019] N74-1	
Barrow, J. R. Engineering appraisal of Southwest Research Institute magnetic crack definer applied to CH rotor blades	Study of structural criteria for composite
[AD-769068] N74-1	
An investigation of pattern recognition of	Analysis of three-dimensional unsteady flow around oscillating wings
aircraft attitudes indicator displays [AD-768345] N74-1	4126 [AIAA PAPER 74-184] A74-18838
BAITER, R. S. Titanium - The bridge to composites A74-1	BREEDLOVE, W. J., JR. Application of an improved unified 6451 subsonic-supersonic potential flow method for
BBCKEB, K. H. Photo-oxidation of aircraft engine emissions at	the aerodynamic analysis of aircraft configurations
low and high altitudes N74-1	[AIAA PAPER 74-186] A74-18841 4277 BRIX, C. W., JR.
BRNSIMON, J. Stratosphere contamination by aircraft and mathematical models	Theoretical investigation of supersonic flow past oscillating cascades with subsonic leading-edge locus
A74-1 BERES, D. P.	7312 (ATRA PAPER 74-14) A74-18843 BRUCE, A. C.
A direct method for calculating flutter speeds [AIAA PAPER 74-27] A74-1	Structural analysis of light aircraft using WASTRAN
BERGHAN, C. A. The design and flight evaluation of a performanc	BRUNETAUD, R.
control system [AD-767786] N74-1	3746 A74-17892
BERMAN, C. B. Noise from nonuniform turbulent flows	BRUTON, D. M. Pollution levels at London (Heathrow) Airport and
[AIAA PAPER 74-2] A74-1 BERTELRUD, A.	N74-14284
A quick look at the state-of-the-art in flight testing of certain aerodynamic parameters related to wind tunnel testing	BRYSON, A. R., JR. Automatic control of a helicopter with a hanging load
[FFA-AU-966] N74-1 BETTS, R. W.	4740 [NASA-CR-136504] N74-13715
The effects of hypersonic viscous interaction on static stability of slender bodies in simulate non-equilibrium flows	
N74-1	
The ac power controllers for solid state distribution system. Volume 1: Design, development, fabrication, and test of hybrid devices	Analytical and experimental investigation of aircraft metal structures reinforced with filamentary composites, Phase 3: Major component development
f AD-768199] 874-1 BILLMAN, P. B.	3903 (NASA-CR-2122) N74-14625 BOLBAN, E. J.
Effects of Ti-6A1-4V alloy metallurgical structures on ultrasonic response characterist	YF-16 stresses advanced technology
λ74-1	6477 BURLEY, R. R.
BILTE, B. A. Three dimensional supersonic flow field analysis of the B-1 airplane by a finite difference	Flight velocity effects on jet noise of several variations of a 48-tube suppressor installed on a plug nozzle
technique and comparison with experimental dat [AIAA PAPER 74-189] A74-1 BIRCHAK, J. R.	
Engineering appraisal of Southwest Research Institute magnetic crack definer applied to CH	installed on a plug nozzle 47 [RASA-TH-X-2918] #74-15466
rotor blades [AD=769068] H74-1	
BLACKERBY, W. T A survey of drag prediction techniques applicabl	
to subsonic and transonic aircraft design N74-1	BURTE, H. H. 4711 Failure experience with and failure anticipation in titanium components
Helicopter inspection design requirements	A74-16476
BLAZOWSKI, W. S.	Technical Evaluation report
Aircraft qas turbine pollutant limitations oriented toward minimum effect on engine	N74-14710 Aircraft drag prediction for project appraisal and
performance N74-1	performance estimation #74-14716
BLOCK, J. A. Bodeling a high pressure ratio centrifugal	
compressor using a low speed of sound gas [AD-767241] #74-1	4444

			•
C		COYME, J. E. Status of the latest turbine disk alloys in	the U S 174-17890
CAGLAYAN, A. K. A self-reorganizing digital flight control	system	CRAMFORD, W. J., III The T700-GE-700 turboshaft engine program [SAE PAPER 736917]	N74-17536
for aircraft [Alla Paper 74-21] CAMBROW, A. G.	174-18808	CREWS, S. T. An unsteady wake model for a bingeless roto	r A74-1814C
Empirical assessment of ATCRBS [ATC-16]	N74-15379	Concepts for a theoretical and experimental	study ons
CAMPRELL, G. STOL tactical aircraft investigation. Vo. Flight control technology	tume 5: N74-13735	(further experiments with progressing/regingtor flapping modes), Phase 7-C [NASA-CR-114711]	N74-14759
[AD-767364] CARR, C. J. FOrce measurements on caret and delta win	•	CRICHLOW, W. J. High cycle fatigue properties of titabium i	n
the incidence range 27 deq less than or alpha less than or equal to 55 deg at M	12.2	COTHT D	374-16 513
(IC-APRO-71-22) CASTLE, H. S.	14705 T4-14705	CRIMI, P. Analysis of stall flutter of a helicopter r blade	
Heavy Lift Helicopter main engines [SAE PAPER 730920]	A74-17537	Dynamic stall	N74-13708 N74-13709
CASTRO, R. Beat-resistant titanium alloys - Introduc the 651 A alloy		[NASA-CR-136473] CROWKHITE, J. D. Static and dynamic helicopter airframe anal	
CPRPCI. T.	374-17891	with NASTRAN	₩74~14616
Remarks on methods for predicting viscous CERMANSKY, N. P.	N74-14718	CROSS, N. L. Ground contamination by fuel jettisoned fro	0
Factors controlling pollutant emissions f turbine engines		-+	N74-14283
CHANNEL, 1. E The S-3A - A new dimension in airborne se	N74-14292 a control	CROSS, R. G., JR. Airborne warning and control system /AWACS/ [AIAA PAPER 74-241] CROW, R. B.	, 174-18655
[AIAA PAPER 74-239] CHARRON, F. Supersonic compressor test facility	A74-19205	Turbojet aircraft engine test cell pollution abatement study	N74-13957
CHING. T.	A74-18603	(AD-768287) CYPKIM, M. R. Aircraft and systems reliability	B14-13751
Reduction of vibration and noise generate planetary ring gears in helicopter airc transmissions	nd by raft <u>174-16979</u>	D	A74-18599
(ASME PAPER 73-PTG-11) CHIN, G.		TINTERPORT I	
Oser's manual for ILSLOC: Simulation for derogation effects on the localizer por the instrument landing system	tion of N74-14361	Three dimensional supersonic flow field and of the B-1 airplane by a finite different technique and comparison with experiment	ce al data
(AD-768049) CHIU, H. H. Noise generation by cylindrical spoilers		[AIAA PAPER 74-189] DAS, A. On some basic and new aspects about the dr	A74-180//
in an air duct [AD-767336] Research on noise generated by ducted air	N74-13730	problem of wings and bodies in supersonic	flows N74-14713
Combustion systems [AD-767337] CLARK, R. A.	N74-14445	DAT, R. Calculation of the dynamic characteristics helicopter structure by the method of br.	of a anch modes A74+18291
Field evaluation of ARTS 2 B (TRACAB)			
[AD-768203]	n74-14360	DAVIES, G. F. Turbojet aircraft engine test cell polluti	
COE, P. L., JB, a worter entrainment model applied to sledelta wings	ender	Turbojet aircraft engine test cell polluti abatement study [AD-768287]	
COE, P. L., JR. 1 vortex entrainment model applied to sledelta wings COHEM. B: Failure experience with and failure anti-	ender 274-17029	Turbojet aircraft engine test cell polluti abatement study {AD-768287} DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability	on N74-13957 a
COMPS. C. P.	a74-17029 cipation a74-16476	Turbojet aircraft engine test cell pollutiabatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. H. Automatic Flight Control System development	on n74-13957 a n74-14765
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEN. B. Failure experience with and failure anticin titanium components COHES, C. P. Trinmed drag and maximum flight efficientail and canard configurations	ender A74-17029 cipation A74-16476 cy of aft	Turbojet aircraft engine test cell polluti abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [MASA-CR-2197]	on N74-13957 d N74-14765 t for N74-18865
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEN, B. Failure experience with and failure anticipation to the components COMBS, C. P. Trimmed drag and maximum flight efficiential and canard configurations [AIAA PAPER 74-69] COBINSKI, A. Development of a graphite horizontal sta	a74-17029 cipation	Turbojet aircraft engine test cell polluti- abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. H. Automatic Flight Control System developmen J.S. Army heavy lift helicopter [AIAA PAPER 74-25] A computer program for aircraft optimal co problems [AD-767919]	on N74-13957 d N74-14765 t for N74-18865
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEN, B. Fallure experience with and failure anticin titanium components COMBS, C. P. Trimmed drag and maximum flight efficientail and canard configurations [AIAA PAPER 74-69] COMINSKI, A. Development of a graphite horizontal sta [AD-768869] COMANAY, J. B. NASTRAN data generation of helicopter fu	a74-17029 cipation a74-16476 cy of aft a74-18813 bilizer a74-14783	Turbojet aircraft engine test cell polluti- abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. H. Automatic Flight Control System developmen U.S. Army heavy lift helicopter [AIAA PAPER 74-25] A computer program for aircraft optimal co problems [AD-767919] DAY, L. E. A pylon to decrease the effects of externa on the stability of aircraft	N74-13957 d N74-14765 t for A74-18865 ntrol N74-13750
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEM. B: Failure experience with and failure anticing titanium components COMBS, C. P. Trimmed drag and maximum flight efficiential and canard configurations [AIAM PAPER 74-69] COMINSKI, A. Development of a graphite horizontal sta [AD-768869] COMMAY, J. H. NASTRAN data generation of helicopter furnish and interactive graphics	a74-17029 cipation a74-16476 cy of aft a74-18813 bilizer n74-14783 selages	Turbojet aircraft engine test cell polluti- abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. H. Automatic Flight Control System developmen U.S. Army heavy lift helicopter [AIAA PAPER 74-25] A computer program for aircraft optimal co problems [AD-767919] DAY, L. E. A pylon to decrease the effects of externa on the stability of aircraft [AD-767913] DEBELLEVAL, J. Representation of hot jet turbulence by me	n74-13957 d N74-14765 t for A74-18865 ntrol N74-13750 1 stores N74-13749
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEN, B: Failure experience with and failure anticination titanium components COHES, C. P. Trimmed drag and maximum flight efficiental and canard configurations [AIAA PAPER 74-69] COBINSKI, A: Development of a graphite horizontal state [AD-768869] COBAWAT, J. H. NASTRAN data generation of helicopter function interactive graphics COOK, C. W. The S-3A - A new dimension in airborne state [AIAA PAPER 74-239]	a74-17029 cipation a74-16476 cy of aft a74-18813 bilizer n74-14783 selages	Turbojet aircraft engine test cell polluti- abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. R. Automatic Flight Control System developmen U.S. Army heavy lift helicopter [AIAA PAPER 74-25] A computer program for aircraft optimal co problems [AD-767919] DAY, L. E. A pylon to decrease the effects of externa on the stability of aircraft [AD-767913] DEBELETVAL, J. Representation of bot jet turbulence by me its infrared emission [NASA-TT-F-15233] DECOMPLET, J.	n74-13957 d n74-14765 t for A74-18865 ntrol n74-13750 cl stores n74-13749 eans of
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEN, B. Failure experience with and failure anticination titanium components COMES, C. P. Trimmed drag and maximum flight efficiental and canard configurations [AIAA PAPER 74-69] COMINSKI, A. Development of a graphite horizontal state [AD-768869] COMMAY, J. H. NASTRAN data generation of helicopter function interactive graphics COOK, C. W. The S-3A - A new dimension in airborne state [AIAA PAPER 74-239] COULMY, G. Development of a method of additional singularities	arder A74-17029 cipation A74-16476 cy of aft A74-18813 bilizer A74-14783 selages A74-14621 ea control A74-19205	Turbojet aircraft engine test cell polluti- abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. N. Automatic Flight Control System developmen U.S. Army heavy lift helicopter [AIAA PAPER 74-25] A computer program for aircraft optimal co problems [AD-767919] DAV, L. E. A pylon to decrease the effects of externa on the stability of aircraft [AD-767913] DEBELLEVAL, J. Representation of hot jet turbulence by me its infrared emission [NASA-TT-7-15233]	n74-13957 d n74-14765 t for A74-18865 ntrol n74-13750 cl stores n74-13749 eans of
COE, P. L., JR. A vortex entrainment model applied to sledelta wings COHEN, B: Failure experience with and failure anticination titanium components COMES, C. P. Trimmed drag and maximum flight efficiental and canard configurations [AIAA PAPER 74-69] COBINSKI, A: Development of a graphite horizontal state [AD-768869] COBAWAY, J. H. NASTRAN data generation of helicopter function interactive graphics COOK, C. W. The S-3A - A new dimension in airborne services [AIAA PAPER 74-239] COULSY, G.	ard-17029 cipation	Turbojet aircraft engine test cell polluti- abatement study [AD-768287] DAVIS, J. A study of the effect of flight density an background noise on V/STOL acceptability [NASA-CR-2197] DAVIS, J. R. Automatic Flight Control System developmen U.S. Army heavy lift helicopter [AIAA PAPER 74-25] A computer program for aircraft optimal co problems [AD-767919] DAVI, L. E. A pylon to decrease the effects of externa on the stability of aircraft [AD-767913] DEBBLETVAL, J. Representation of hot jet turbulence by me its infrared emission [NASA-TT-F-15233] DECOUPLET, J. Emission of gaseous pollutants by turbojet	n74-13957 d N74-14765 t for A74-18865 ntrol N74-13750 cl stores N74-13749 eans of N74-14383 engines A74-17395

BPC tapated of -			
DESJARDINS, S. P. Vehicle crashworthiness		BL-HESSIRI, I. A.	
	A74-17776	The divided combustion chamber concept and for control of SI engine exhaust air pol	l design
DEVARAKONDA, V. K.		emissions	ridtant
Engineering evaluation of age life extens	sion, T-10		N74-15454
harnesses, risers and T-10 troop chest parachute canopies. Supplement 1: 1960	reserve	ELLISON, T. A.	
year classes	+ - 1905	Avionics design for maintainability - Are gaining or losing	₩0
[AD-767711]	N74-13743	(SAE PAPER 7308621	A74-17531
DIAMOND, E. D.		ELSANKÉR, W. K.	
Automatic Flight Control System developme U.S. Army beavy lift helicopter	ent for	STOL tactical aircraft investigation, exte	rnally
[AIAA PAPER 74-25]	A74-18865	blown flap, Volume 5, part 3: Stability control derivative accuracy requirements	and
DICKINSON, P. J.		effects of augmentation system design	and
Computer prediction of aircraft noise	170 40004	[AD-767182]	N74-13757
DIEBL, L. A.	A74-19051	ERICKSON, L. L.	
The effect of water injection on mitric of	xide	Transonic single-mode flutter and buffet of aspect ratio wing having a subsonic airf	of a low
emissions of a gas turbine combustor by	ırning	(NASA-TN-D-7346)	N74-14631
ASTM Jet-A fuel [NASA-TM-X-2958]	W7/1-1/1650	ERLMRIER, H.	
Effect of water injection on mitric oride	N74-14650	Supersonic fuels from medium oils produced thermal cracking of crude oil residues	l by the
emissions of a gas turbine combustor bu	rning	[DFVLR-SONDDR-301]	A74-18925
natural gas fuel [NASA-TH-X-2959]		ERHOLENKO, S. D.	
DIETZ, C. G.	R74-14651	Calculation of the aerodynamic characteris	tics of
Development of a graphite horizontal stab	ilizer	a wing system moving at subsonic speed n or smooth water surface	ear land
[AD-768869]	N74-14783	or smooth water surface	A74-18681
DIBTZ, C. R.	_	BUVRARD, D.	
Simplified aircraft performance methods: required for single and tandem rotor he	Power	A direct method for computing the steady f	low at
in hower and forward flight	TICOPTEES	Mach number one past a given wing airfoi	
ΓAD-7687691	N74-14777		174-16963
DOBBINS, A. Structural analysis of light simulation	44	F	
Structural analysis of light aircraft usi	ng mastram A74-18664		
DOCKSUBLL, S.		FACKRELL, J. B. The flow field and pressure distribution o	#
US Army helicopter hydraulic servocylinde	r	isolated road wheel	I an
reliability and maintainability investi	gation	[IC-AERO-72-14]	N74-14706
DONALDSON. C.	N74-13731	PALARSKI, H. D.	
A method of calculating aircraft wake wel	ocity	Wind tunnel investigation of a large-scale swept-wing jet transport model with an e	25 deq
profiles and comparison with full-scale experimental measurements		blowing triple-slotted flap	rtarnar
[AIAA PAPER 74-39]	174-18747	[WASA-TH-X-62197]	874-13721
DOWELL, E. H.		PATHY, A. F. A. The unsteady circulation distribution in r	
Plutter computer program and lifting surf	&CB	and its application to noise studies	otors
theory with boundary layer [NASA-CR-136559]	w70 4070		N74-14437
DRAPER, G. T.	N74-14707	FERRI, A.	
STOL tactical aircraft investigation. Vo.	lume 6:	The jet engine design that can drastically oxides of nitrogen	reduce
Air cushion and ground mobility study [AD-767300]		[AIAA PAPER 74-1601	A74-18797
DRAPIER, C.	N74-13736	Reduction of NO formations by premixing	
Development of cold headable titanium #11.	ovs for	PIELDING, J.	N74-14272
the 'Concorde' supersonic jet		Manufacturing exercise involved in the red	esian of
DU PEU, A. N.	A74-16554	the Hawker Siddeley Trident /tri-jet/ fu	selage
The Type 3B altitude measurement system			A74-16445
	A74-17276	FISCHER, R. Improvement of the downflow conditions beh:	:_a
DUNCAN, R. M.		integrated shrouded propeller	ind an
Applications of the high strength alloy Ti-4A1-4Mo-2Sn+C.5Si in European aircrai	F4	· ·	A74-17801
with an ediopedia diffical	A74-16450	PLERMAN, E. L.	
_		Merodynamic forces and moments on a slender with a jet plume for angles of attack up	r body to 188
E		dedrees	20 100
PASON, W.		[AIAA PAPER 74-110] FLETCHER, R. S.	A74-18776
V/STOL tilt rotor aircraft study. Volume	10:	A preliminary study on the influence of fue	. 1
Performance and stability test of A 1-16	1.622	staging on mitric oxide emissions from ga	37
Froude scaled Boeing Vertol Model 222 ti aircraft (Phase 1)	ilt rotor	turbine combustors	
[NASA-CR-114603]			N74-14301
	N74-13727	POCT. E.	11.4 14301
EATON, C.	N74-13727	FOGY, W. A new ILS localizer for regional airports	14307
Structural analysis of light aircraft using	IG NASTRAN	A new ILS localizer for regional airports	A74-18901
Structural analysis of light aircraft using [AIAA PAPER 74-257] RCER, A.	NASTRAN A74-18664	A new ILS localizer for regional airports PORMEY, D. M., JR.	A74-18901
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flo	NASTRAN A74-18664	A new ILS localizer for regional airports PORMET, D. M., JR. Failure experience with and failure anticing	A74-18901
Structural analysis of light aircraft using [AIAA PAPER 74-257] RCER, A. Analysis of three-dimensional unsteady floorscillating wings	ng NASTRAN A74-18664 Dw around	A new ILS localizer for regional airports PORMET, D. H., JR, Pailure experience with and failure anticip in titanium components	A74-18901
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184] EDMONSON, R. B.	NASTRAN A74-18664	A new ILS localizer for regional airports PORMET, D. M., JR. Failure experience with and failure anticit in titanium components FOI, C. H., JR,	A74-18901
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184]	ng NASTRAN A74-18664 Dw around	A new ILS localizer for regional airports PORMEY, D. M., JR. Failure experience with and failure anticip in titanium components POY, C. H., JR, Application of an improved unified	174-18901 Pation 174-16476
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady floorscillating winds [AIAA PAPER 74-184] EDMONSON, R. B. B-1 cost/weight trade methodology	ng NASTRAN A74-18664 Dw around	A new ILS localizer for regional airports PORNEY, D. M., JR. Failure experience with and failure anticit in titanium components POI, C. H., JR, Application of an improved unified subsonic-supersonic potential flow method	174-18901 Pation 174-16476
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184] EDMONSON, R. B. B-1 cost/weight trade methodology EJIRI, B.	ng NASTRAN A74-18664 ow around A74-18838	A new ILS localizer for regional airports PORNEY, D. M., JR. Failure experience with and failure anticit in titanium components POI, C. H., JR, Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations	174-18901 Pation 174-16476
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184] EDMONSON, R. B. B-1 cost/weight trade methodology EJIHI, B. Measurements of rolling moments acting on stabilizer of T-tails oscillating in your	A74-18838 A74-16447	A new ILS localizer for regional airports FORMET, D. H., JR. Failure experience with and failure anticit in titanium components FOI, C. H., JR. Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186]	174-18901 Pation 174-16476
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184] EDMONSON, R. B. B-1 cost/weight trade methodology EJIRI, B.	A74-18838 A74-16447	A new ILS localizer for regional airports PORMET, D. M., JR. Failure experience with and failure anticip in titanium components POI, C. H., JR, Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] FOI, W. J.	A74-18901 pation A74-16476 for A74-18841
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184] EDMONSON, R. B. B-1 cost/weight trade methodology EJIHI, B. Measurements of rolling moments acting on stabilizer of T-tails oscillating in your	AT NASTRAN A74-18664 ON ATOUND A74-18838 A74-16447	A new ILS localizer for regional airports FORMET, D. H., JR. Failure experience with and failure anticit in titanium components FOI, C. H., JR. Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186]	A74-18901 pation A74-16476 for A74-18841
Structural analysis of light aircraft using [AIAA PAPER 74-257] ECER, A. Analysis of three-dimensional unsteady flooscillating wings [AIAA PAPER 74-184] EDMONSON, R. B. B-1 cost/weight trade methodology EJIHI, B. Measurements of rolling moments acting on stabilizer of T-tails oscillating in your	AT NASTRAN A74-18664 ON ATOUND A74-18838 A74-16447	A new ILS localizer for regional airports PORMET, D. M., JR. Failure experience with and failure anticip in titanium components POI, C. H., JR, Application of an improved unified subsonic-supersonic potential flow method the aerodynamic analysis of aircraft configurations [AIAA PAPER 74-186] FOI, M. J. Flight study of a vehicle operational statu	A74-18901 pation A74-16476 for A74-18841

FRY, 6. P. Importance of the means of engine condition	n.	Recent developments in sonic-boom simulation	on using
surveillance	a74-18598	shock tubes	A74-16384
PUHS, A. B. Pollution control of airport engine test for		GLUSHCHENKO, M. 1. A study of the combined wibrations of the	
POJIEDA, H.	N74-14285	disk-blade system of a turboprop engine to wheel	
Ground operation tests of flying test bed aircraft at National Aerospace Laborator	y	GODSHALL, P. A.	A74-18088
[NAL-TR-319]	N74-14764	Artificial development of an atmospheric be layer flow model in a wind tunnel	N74-13701
G		GOGGIBS, W. B. New concepts in AMTI radar - Mulling effect	
GABRIELLI, G. Buckling loads and minimum weight of comprecurved ribbed aluminum alloy panels	essed	Doppler filter/multi-element horn array	A74-17252
GAIDACRUK, V. B.	A74-16822	GOLDARY, I. P. Reat transfer investigation in a high-temper	erature
Experimental study of metal-plastic coupling tension		gas flow spreading over a plane surface	A74-18684
Experimental investigation of glass-plastic	A74-18648 c and	GOLDSTRIB, H. Unsteady lift forces on highly cambered air	rfoils
metal-plastic joints under shear	A74-18697	moving through a qust [Aliah PAPER 74-88] GOLDSTRIM, S. E.	A74-18897
GALLAGEER, H. M. Titanium flamecutting reduces airframe cos	ts A74-16760	Trimmed drag and maximum flight efficiency tail and canard configurations	
GARBUCCI, B. Takeoff and landing performance and noise		[AIAA PAPER 74-69] GOLIAKOV, L. P.	A74-18813
measurements of a deflected slipstream S' airplane with interconnected propellers		On the modes of icing of symmetrical lifti surfaces	
rotating cylinder flaps [NASA-TH-X-62320]	N74-13720	GORBATENKO, S. A.	A74-18987
GAONKAR, G. H. Concepts for a theoretical and experimental	l study	Calculation and analysis of aircraft motion [NASA-TT-F-757]	n N74-14751
of lifting rotor random loads and wibrat Phase 1 [NASA-CR-114707]	N74-14755	GORODETSKII, S. S. A study of the damageability of turbine bl. aircraft gas-turbine engines after opera	
Concepts for a theoretical and experimenta of lifting rotor random loads and wibrat		running in	A74-18085
Phase 2 [NASA-CR-114708] GARDHER, C. G:	N74-14756	GOTTLIBB, J. J. Recent developments in sonic-boom simulati shock tubes	on using
Engineering appraisal of Southwest Researc Institute magnetic crack definer applied	h to CH47	GOT, R.	A74-16384
rotor blades [AD-769068]	H74-14778	The German law for protection against the aircraft	
GAUDET, L. Measurements of the drag of some character		GRABP, J. D.	A74-18265
aircraft excrescences immersed in turbul boundary layers	ent N74-14714	Development of requirements for, and evalu of, manufacturer advanced design aircraf [SAE PAPER 730948]	
GAUKHAM, Y. N. Optimal capabilities of hypersonic passeng aircraft on kerosene fuel	er	GRAIVOROMSKII, V. A. A method of calculating the flow around a arbitrary planform, positioned on a cyli	
[AD-767887] GAUL, J. W.	N74-13737	bod₹	A74-18632
Automatic Flight Control System developmen U,S, Army heavy lift helicopter		GRANT, G. Erosion prediction in turbomachinery due t	o
[AILA PAPER 74-25] GAUTHIER, C. M., The ac power controllers for solid state	A74-18865	environmental solid particles [AIAA PAPER 74-16] GRAVES, D. B.	A74-18732
distribution system Volume 1: Design, development, fabrication, and test of hy	brid	The new Advanced Airborne Command Post fAIAA PAPER 74-240]	A74-18654
devices [AD-768199]	N74-13903	GRAY, H. R. Hot-salt stress-corrosion of titanium allo related to turbine engine operation	ys as
GEDNEI, R. T. Airborne profiling of ice thickness using pulse radar	a short	GREGG, G. E.	A74-1660C
GBISSIBB, 9. Calculation of potential flow about axiall	à74-17810	Developmental design, fabrication, and tes acoustic suppressors for fans of high by turbofan engines	
symmetric fuselages, annular profiles an inlets	d engine	[NASA-CR-2338] GRIAZNOV, B. A.	N74-13724
(NASA-TT-F-15213) GERHARDT, EJ. Improvement of the downflow conditions beh	#74-13707	A study of the damageability of turbine bl aircraft gas-turbine engines after opera running in	
integrated shrouded propeller	A74-17801	GRIGOR'RY, L. S.	A74-18085
GIULIABETTI, D. Takeoff and landing performance and noise	A/7 1/001	A film thermocouple with a platinum electr thermometry of qas turbine engine blades	
measurements of a deflected slipstream S airplane with interconnected propellers	TOL and	GRIGOR BYA, T. P.	A74-18686
rotating cylinder flaps [NASA-TM-X-62320]	N74-13720	Control of an elastic aircraft	A74-18271

GROBECKER, A. J.		HARMSEN, S.	
United States Department of Transportation research program for high altitude poly		Vertical take-off and landing aircraft	A74-18178
GROBHAW, J.	N74-14273	BARPER, T. L.	
Design and evaluation of combustors for a	educing	Definition of study objectives for integrandule development	ated crew
aircraft engine pollution	H74-14302	[AD-769065] HARRIS, W. L., SR.	N74-14773
GROENSKEI, K. B.		Experimental investigation of sonic boom	
A systematic approach to the study of the connection between emission and ambient	e air	propagation through variable flow field	ls 174-16385
concentrations		HARVEI, J. K.	
GROSZEK, A.	N74-14293	The flow field and pressure distribution isolated road wheel	of an
Automatic balancing of an aircraft	A74-17804	[IC-ABRO-72-14]	N74-14706
GROTH, H, W.		HAYPS, R. D. Application of advances in structures and	ı
Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source	ance with	materials to the design of the TF-17 ai	rplane
[AIAA PAPER 74-91]	374-1876B	HEAD, V. L,	A74-17534
Sonic inlet noise attenuation and perform a J-85 turbojet engine as a noise source	ance with e	Flight velocity effects on jet noise of a variations of a 48-tube suppressor inst	everal
[NASA-TM-X-71488] GROVE, R. D.	¥74-14384	a pluq nozzle	arted on
A real-time digital program for estimatin	Р	[NASA-TH-X-2919] Hebert, J., Jr.	N74-15465
aircraft stability and control paramete flight test data by using the maximum l	rs from	STOL tactical aircraft investigation, Vo	lume 2:
method	Trefigood	Design compendium [AD~767561]	N74-13733
[NASA-TH-X-2788] GUPTA, N. K.	N74-13802	STOL tactical aircraft investigation, vo	lume 4:
Automatic control of a helicopter with a	hanging	Wind tunnel data analysis [AD-767363]	N74-13734
load [NASA-CR-136504]	N74-13715	STOL tactical aircraft investigation. Vo	
·	214 13.13	Flight control technology [AD-767364]	N74-13735
Н		STOL tactical aircraft investigation. Vo	lume 6:
A study of the effect of flight density a	_ 4	Air cushion and ground mobility study [AD-767300]	N74-13736
background noise on V/STOL acceptabilit	na Y	EBBR. O.	M/4~13/30
[NASA-CR-2197] HAPTKA, R. T.	N74-14765	Air traffic control	
On repetitive flutter calculations in str	uctural	HEIGHWAY, J. R.	A74-18182
desiqu [Alaa Paper 74-141]	A74-18789	Airborne profiling of ice thickness using pulse radar	a short
HAGEHAIER, D. J.			
Nondestructive detection of hydrides and			174-17810
Nondestructive detection of hydrides and alpha-case in titanium alloys		BELL, W. H. Flat rolled beta titanium allows for airs	
Nondestructive detection of hydrides and alpha-case in titanium alloys	A74-1 6482	HEIL, W. H. Flat rolled beta titanium alloys for airf: application	ra∎e
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGENARM, W. An abalytic approximate calculation of the	·	Flat rolled beta titanium alloys for airf: application HBISE, G.	rame 274-16449
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and lo.	e Ads on	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight webic	rame 174-16449
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and lo- aircraft with both rigid and elastic will structure	e ads on ng	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example	rame 174-16449 le missile
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and local craft with both rigid and elastic with structure [DGLR PAPER 73-078] HALFPERNY, P. F.	e Ads on	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068]	rame 174-16449
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and loaircraft with both rigid and elastic will structure [DGLR PAPER 73-078]	e ads on ng A74-17185	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLE PAPER 73-068] HENDERSON, R. E. Aircraft gas turbine pollutant limitations	174-16449 le missile 174-17177
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and local craft with both rigid and elastic with structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A.	e ads on ng A74-17185 A74-17740	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HENDERSON, R. E	174-16449 le missile 174-17177
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wing structure [DGLR PAPER 73-078] HALFPRMY, P. F. Utility analysis in weight control	e ads on ng A74-17185 A74-17740	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSOM, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine	174-16449 le missile 174-17177
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic with structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integration of the process of the pro	e ads on ng A74-17185 A74-17740	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HENDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne see	174-16449 le missile 174-17177 s 174-14304
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wind structure [DGLR PAPPER 73-078] HALFPRMMY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integration of the study objectives for integration of the study objectives. [AD-769065] HALSEY, M. D. Hethods for the design and analysis of jet	eads on ng A74-17185 A74-17740 ated crew N74-14773	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSOM, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea	174-16449 le missile 174-17177 s 174-14304
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] BALSEY, M. D. Methods for the design and analysis of jet airfoils [AJAA PAPER 74-1881]	ads on ng A74-17185 A74-17740 ated crew N74-14773	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne see [AIAA PAPER 74-239] HESSIVEDT, E. Beffect of supersonic transport upon the or	174-16449 le missile 174-17177 s 174-14304 1 control 174-19205
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic wind structure [DGLR PAPER 73-078] HALFPENNY, P. P. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, W. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HANDLEY, J. C.	A74-1833	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSOW, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] EMSSIVEDT, E. Effect of supersonic transport upon the or layer, studied in a two-dimensional	174-16449 le missile 174-17177 s 174-14304 1 control 174-19205
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] BALSEY, M. D. Methods for the design and analysis of jet airfoils [AJAA PAPER 74-1881]	A74-1833	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSTWEDT, E. Biffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport	174-16449 le missile 174-17177 s 174-14304 1 control 174-19205
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPRMMY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated by the structure of the development [AD-769065] HALSEY, M. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HAMDLEY, J. C. Combustion generated moise in turbopropulations systems [AD-768615]	A74-1833	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, E. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSTWEDT, E. Effect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport	174-16449 le missile 174-17177 s 174-14304 1 control 174-19205 20ne 174-14278
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPRMMY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulations of the systems [AD-768615] HAMINK, D. K. An approach toward optimizing material contents.	A74-17185 A74-17740 Ated crew A74-14773 E-flapped A74-18833 Sion A74-15666	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSTWEDT, E. Biffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport	174-16449 le missile 174-17177 s 2 174-14304 1 control 174-19205 200e 174-14278
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPRMY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulations of the design and analysis of jet airfoils [AD-768615] HAHIMK, D. K. An approach toward optimizing material cospart function in advanced powerplants	A74-17185 A74-17740 Ated crew A74-14773 t-flapped A74-18833 Sion B74-15666 St and	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne see [AIAA PAPER 74-239] HESSTVEDT, E. Biffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEYMOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, E. G.	174-16449 le missile 174-17177 s 174-14304 1 control 174-19205 20ne 174-14278
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPRMMY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulations aystems [AD-768615] HAMINK, D. K. An approach toward optimizing material compart function in advanced powerplants [SAE PAPER 730909] HAMEE, C. B.	A74-17185 A74-17740 Ated crew A74-14773 t-flapped A74-18833 Sion A74-15666 St and A74-17535	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HENDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSIVEDT, E. Effect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HENWOOD, J. B. Parameters controlling nitric oxide emissions gas turbine combustors	174-16449 le missile 174-17177 8 174-14304 1 control 174-19205 200e 174-14278 1008 from
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic winstructure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, W. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HANDLEY, J. C. Combustion generated noise in turbopropulations systems [AD-768615] HAHINK, D. K. An approach toward optimizing material cospart function in advanced powerplants [SAE PAPER 730909] HAMKE, C. B. The influence of wing loading on turbofan	A74-17185 A74-17740 Ated crew M74-14773 A-flapped A74-18833 Sion M74-15666 St and A74-17535	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne see [AIAA PAPER 74-239] HESSITEDT, E. Biffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HENGOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, H. G. A color schlieren system HIMES, J. D.	174-16449 le missile 174-17177 le 174-14304 l control 174-19205 zone 174-14278 lons from 174-14291 174-17806
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Hethods for the design and analysis of jet airfoils [AIAM PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulary systems [AD-768615] HAMINK, D. K. An approach toward optimizing material cospart function in advanced powerplants [SAE PAPER 730909] HAMKE, C. B. The influence of wing loading on turbofan STOL transports with and without externations of the state of the sta	A74-17185 A74-17740 Ated crew M74-14773 A-flapped A74-18833 Sion M74-15666 St and A74-17535	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HENDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSIVEDT, E. Biffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HENGOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, H. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal co	174-16449 le missile 174-17177 le 174-14304 l control 174-19205 zone 174-14278 lons from 174-14291 174-17806
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic winstructure [DGLR PAPER 73-078] HALFPENNY, P. P. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Hethods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulation systems [AD-768615] HAMINK, D. K. An approach toward optimizing material cospart function in advanced powerplants [SAE PAPER 730909] HAMKE, C. R. The influence of wing loading on turbofan STOL transports with and without externation in laps [NASA-CR-2320] EANKLER, J. R.	A74-17185 A74-17185 A74-17740 Ated crew M74-14773 A-flapped A74-18833 A74-18666 A74-17535 A74-17535 A74-17535 A74-13718	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne see [AIAA PAPER 74-239] HESSTYDET, E. Effect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEYWOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, H. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal cor problems [AD-767919]	174-16449 le missile 174-17177 le 174-14304 l control 174-19205 zone 174-14278 lons from 174-14291 174-17806
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPRMMY, P. P. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, W. D. Methods for the design and analysis of jet airfoils [AIAM PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulary systems [AD-768615] HAMINK, D. K. An approach toward optimizing material compart function in advanced powerplants [SAE PAPER 730909] HAMKE, C. B. The influence of wing loading on turbofan STOL transports with and without externation flaps [NASA-CR-2320] HAMKINE, J. R. Definition of study objectives for integral	A74-17185 A74-17185 A74-17740 Ated crew M74-14773 A-flapped A74-18833 A74-18666 A74-17535 A74-17535 A74-17535 A74-13718	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSTWEDT, E. Beffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEMMOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, W. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal co problems [AD-767919] HIMTERENOUSE, E. G.	174-16449 le missile 174-17177 174-14304 1 control 174-19205 2 cone 174-14278 lons from 174-14291 174-17806 2 control 174-17806 2 control 174-13750
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic winstructure [DGLR PAPER 73-078] HALFPENNY, P. P. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Hethods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropulation systems [AD-768615] HAMINK, D. K. An approach toward optimizing material cospart function in advanced powerplants [SAE PAPER 730909] HAMKE, C. R. The influence of wing loading on turbofan STOL transports with and without externation in laps [NASA-CR-2320] EANKLER, J. R.	A74-17185 A74-17740 Ated crew A74-14773 A74-18833 AFF-18666 AFF-17535 AFF-17535 AFF-17535 AFF-17535 AFF-17535 AFF-17536	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] EMSSIVEDT, E. Effect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEMMOOD, J. B. Parameters controlling nitric oxide emission gas turbine combustors HILL, M. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal color problems [AD-767919] HIMTEREOSER, E. G. A study of the effect of flight density am background noise on V/STOL acceptability	174-16449 le missile 174-17177 s 174-14304 1 control 174-19265 200e 174-14278 1008 from 174-14291 174-17806 174-17806
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control EALL, A. A. Definition of study objectives for integrated and development [AD-769065] BALSEY, M. D. Methods for the design and analysis of jet airfoils [AIAA PAPER 74-188] HANDLEY, J. C. Combustion generated noise in turbopropulations aystems [AD-768615] HABIUK, D. K. An approach toward optimizing material compart function in advanced powerplants [SAE PAPER 730909] HABKE, C. B. The influence of wing loading on turbofan STOL transports with and without externations flaps [HASS-CR-2320] EANKINE, J. R. Definition of study objectives for integrational development [ID-769065] HANSON, D. B.	A74-17185 A74-17185 A74-17740 Ated crew A74-14773 A-14773 A-18833 A5ion A74-18666 A74-17535 A74-17535 A74-17535 A74-17536 A74-17536 A74-17536 A74-17537	Flat rolled beta titanium alloys for airf: application HBISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSIVEDT, E. Effect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEYWOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, W. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal compoblems [AD-767919] HIMTERENDER, E. G. A study of the effect of flight density am background noise on W/STOL acceptability [WASA-CR-2197] HIMSON, W. C.	174-16449 le missile 174-17177 s 174-14304 1 control 174-19205 20ne 174-14278 lons from 174-17806 20ntrol 174-17806 20ntrol 174-17806 20ntrol 174-17806 20ntrol 174-17806 20ntrol 174-17806
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, W. D. Methods for the design and analysis of jet airfoils [AIA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropular systems [AD-768615] HAHINK, D. K. An approach toward optimizing material compart function in advanced powerplants [SAE PAPER 730909] HAMEZ, C. B. The influence of wing loading on turbofan STOL transports with and without externation flaps [NASA-CR-2320] HAMKLUE, J. R. Definition of study objectives for integrated and development [AD-769065] HAMSON, D. B. The spectrum of turbomachine rotor noise of	A74-17185 A74-17740 Ated crew M74-14773 A74-18833 A5ion M74-18666 A74-17535 Powered A74-13718 Ated crew M74-13773	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitation: oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne see [AIAM PAPER 74-239] EMSSTYMDT, E. Beffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HENWOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, H. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal co problems [AD-767919] HIMTEREDUSER, E. G. A study of the effect of flight density an background noise on Y/STOL acceptability [RASA-CR-2197] HIMSON, N. C. Orientation-error accidents in regular Arm	174-16449 le missile 174-17177 s
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An abalytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPRMMY, P. F. Utility analysis in weight control EALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, M. D. Methods for the design and analysis of jet airfoils [AIAM PAPER 74-188] HANDLEY, J. C. Combustion generated noise in turbopropulary systems [AD-768615] HABINK, D. K. An approach toward optimizing material compart function in advanced powerplants [SAE PAPER 730909] HABEZ, C. B. The influence of wing loading on turbofan STOL transports with and without externation flaps [HASA-CB-2320] HANKLEE, J. R. Definition of study objectives for integrated and development [AD-769065] HANSON, D. B. The spectrum of turbomachine rotor noise coinlet quide wane wakes and atmospheric to	A74-17185 A74-17740 Ated crew M74-14773 A74-18833 A5ion M74-18666 A74-17535 Powered A74-13718 Ated crew M74-13773	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSTWEDT, R. Effect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEYMOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, H. G. A color schlieren system HIMES, J. b. A computer program for aircraft optimal compositions [AD-767919] HIMTERENISER, E. G. A study of the effect of flight density and background noise on V/STOL acceptability [FMSA-CR-2197] HIMSON, W. C. Orientation-error accidents in regular Arm aircraft during fiscal year 1970: Relation-dense and cost	174-16449 le missile 174-17177 s
Nondestructive detection of hydrides and alpha-case in titanium alloys HAGEMANN, W. An analytic approximate calculation of the nonlinear landing impact motions and locaircraft with both rigid and elastic win structure [DGLR PAPER 73-078] HALFPENNY, P. F. Utility analysis in weight control HALL, A. A. Definition of study objectives for integrated and development [AD-769065] HALSEY, W. D. Methods for the design and analysis of jet airfoils [AIA PAPER 74-188] HAMDLEY, J. C. Combustion generated noise in turbopropular systems [AD-768615] HAHINK, D. K. An approach toward optimizing material compart function in advanced powerplants [SAE PAPER 730909] HAMEZ, C. B. The influence of wing loading on turbofan STOL transports with and without externation flaps [NASA-CR-2320] HAMKLUE, J. R. Definition of study objectives for integrated and development [AD-769065] HAMSON, D. B. The spectrum of turbomachine rotor noise of	A74-17185 A74-17740 Ated crew M74-14773 A-flapped A74-18833 Sion M74-15666 St and A74-17535 Powered A74-13718 Ated crew M74-13773 Caused by Curbulence	Flat rolled beta titanium alloys for airf: application HEISE, G. Comparative study of various flight vehic: propulsion systems, using an air-to-air as an example [DGLR PAPER 73-068] HEWDERSON, R. E. Aircraft gas turbine pollutant limitations oriented toward minimum effect on engine performance HEPPE, R. R. The S-3A - A new dimension in airborne sea [AIAA PAPER 74-239] HESSTWEDT, E. Beffect of supersonic transport upon the or layer, studied in a two-dimensional photochemical model with transport HEMMOOD, J. B. Parameters controlling nitric oxide emissi gas turbine combustors HILL, H. G. A color schlieren system HIMES, J. D. A computer program for aircraft optimal co problems [AD-767919] HIMTERENUSER, E. G. A study of the effect of flight density am background noise on V/STOL acceptability [NASA-CR-2197] HIMSOW, M. C. Orientation-error accidents in regular Arm aircraft during fiscal year 1970: Relat	174-16449 le missile 174-17177 s

174-18858

		en de la companya de	
HODGES, J. C.			
Definition of study objectives for integra	ited crea		
module development	N74-14773	IASINSKII, P. G.	-
[AD-769065] HOHRNESSE, K. H.		analytical design of optimal monolithic pan	e15 A74-18642
An unsteady wake model for a hindeless rot	tor		A/4-10042
	A /4-10140	ICHIKAWA, T. Measurements of rolling moments acting on t	he
Concepts for a theoretical and experimenta	al study	stabilizer of T-tails oscillating in Yaw	
of lifting rotor random loads and wibrat	tions,	[NAL-TR-324]	N74-14744
Phase 1	N74-14755	TI THSKIT. V. V.	
[NASA-CR-114707] Concepts for a theoretical and experiments		come enecific characteristics of small gas	
of lifting rotor random loads and vibrat	tions,	turbines and the modeling problems of the	ir wind
Phase 2		tunnel testing	A74-18682
[NASA-CR-114708]	N74-14756	_	
Concepts for a theoretical and experiment	al study	Takeoff and landing performance and noise	
of lifting rotor random loads and wibrat (the effects of some rotor feedback syst	tams on	measurements of a deflected slipstream Si	01
rotor-body dynamics), Phase 7-A		airplane with interconnected propellers a	,nd
[NASA-CR-114709]	x74-14757	rotating cylinder flaps	N74-13720
Concepts for a theoretical and experiments	al study	[NASA-TH-X-62320]	H14 (314)
of lifting rotor random loads and wibra	tions	ISOGAL, K. Lifting-surface theory for an oscillating T	-tail
(identification of lifting rotor system	1 Bhace		A/4-17012
parameters from transient response data), FRESE	Measurements of rolling moments acting on t	.he
7-B [NASA-CR-114710]	N74-14758	stabilizer of T-tails oscillating in yaw	
Concepts for a theoretical and experiment		[NAL-TR-324]	N74-14744
of lifting rotor random loads and Wibra	tions	ISRAEL, D. R. Puture air traffic control - Ground, cockpi	t. or
(further experiments with progressing/re	eqressinq	space	
rotor flapping modes), Phase 7-C	N79-14759	[AIAA PAPER 74-262]	A74-18669
[NASA-CR-114711]	414-14197	, 	
HOBN, P. W. Helicopter inspection design requirements		}	
[AD-769061]	N74-14781	_	
HOLDEMAN, J. D.		JACKSON, R. P. Putting all our noise technology to work	
Dispersion and dilution of jet aircraft e	xhaust at	Putting all our noise technology to work	A74-17049
high-altitude flight conditions	A74-18749	JACOBSON, I. D.	
[AIAA PAPER 74-41]	214 10143	Magnus characteristics of arbitrary rotation	ng bodies
HOLLEY, W. B. Hulti-input, nulti-output regulator designment	n for	[AGARD-AG-171]	N74-13710
constant disturbances and non-zero set	points	JAMAIL, J. D.	irolane
with application to automatic landing i	.a a	Government responsibility for damages in a crash cases when weather is a factor	LPIUNC
crosswind	#74-15378	CIRSI Cases when wearact is a month	174-18098
[NASA-CR-136618]	874-15570	JANSSENS, G.	
NOLT, P. S. New concepts in AMTI radar - Nulling effe	cts of	Supersonic compressor test facility	104A2
Doppler filter/multi-element horn array	7		A74-18603
	<u> 174-17252</u>	JANTZEN, E. Aviation fuels and lubricants	
HOWARD, R. W.	iroraft -	Walfillow freezy mus rapprograms	A74-18180
Automatic flight controls in fixed wing a The first 100 years	IIICIALL	JEANS, L. L.	
The Little top years	<u> 174-18296</u>	Application of damage tolerance technology	to
HOWE, D.		advanced metallic fighter wing structure	A74-18738
performance characteristics of short haul	L	[AIAA PAPER 74-29]	A74-10750
transport aircraft intended to operate	from	JOATTON, R. Stratosphere contamination by aircraft and	
reduced length runways	N74-13716	mathematical models	
[CRANFIELD-AERO-18] HUBBARD, R. T. J.	877 10774		A74-17312
annlications of the bigh strength alloy		JOHNS, A. L.	1
Ti-4A1-4Mo-2Sn-0.5Si in European aircra	ft projects	Flight velocity effects on jet noise of se	vera1
•	A74-16450	variations of a twelve-chute suppressor installed on a plug nozzle	
SUPPRAN, J. L.	5 -	[NASA-TH-X-2918]	N74-15466
US army helicopter hydraulic servocylinde reliability and maintainability investi	gation	JOVES. R. B.	
(AD-767243)	N74-13731	Design and evaluation of combustors for re	ducing
RRANKT D.		aircraft engine pollution	w711_10202
Nonlinear airfoil theory with allowance i	for ground	TANTO D. M.	#74-14302
effects	A74-17270	JONES, R. T. Transonic transport wings - Oblique or swe	nt
* *	H14-11210	Ildusonio erguspora senda annia an anni	A74-17048
HUBT, G. K. Similarity requirements for aeroelastic r	models of	JORDAN, L.	
helicopter rotors		User's manual for ILSLOC: Simulation for	
[ARC-CP-1245]	H74-14767	derogation effects on the localizer port	10B OF
NINT. R. B.		the instrument landing system [AD-768049]	N74-14361
Failure analysis of helicopter external		JOSEPH, D. J.	
cargo-handling systems [AD-767254]	¥74-13729	Comparison of the flying qualities of the	A-7D
HORRICZ, H.		aircraft with the requirements of MIL-F-	8785B ASG
Ablation	_	[AD-768390]	M74-14768
	A74-17103	JUDD, T. H.	mot 1 cm
SUTTON, P. G.	T4.0	A modified design concept, utilizing deck prediction, for the A-7E automatic carri	er erion
The drag of externally carried stores:	Tra	landing system	
prediction and alleviation	B74-14729	[AD-767691]	¥74-13739
		Jurrgeus, R. J.	
		Titanium - The bridge to composites	174-16451
			A , 10 4J 1

	KOHLMAN, D. L.
K	Plight test data for a Cessna Cardinal
KACPRZYBSKI, J. J.	NASA-CE-2337 N74-14752
An experimental analysis and buffet investigation of the shockless lifting airfuil no. 1 [NRC-13673] 874-14708	A study of the combined vibrations of the : disk-blade system of a turboprop engine turbine wheel
Drag of supercritical airfoils in transonic flow N74-14719	A74-18988
User's manual for ILSLOC: Simulation for	LDF powered balloom program
derogation effects on the localizer portion of	KORH, J. A.
the instrument landing system [AD-768049] N74-14361 KAI, T.	The effect of inlet distortion on the performance and stability of the low-speed spool of a turbofan engine
Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory	(AIAA PAPER 74-234] A74-18855
(NAL-TR-319 N74-14764 KANIA, P. The Alpha Jet programme	On the modes of icing of symmetrical lifting surfaces
174-18902	KOVAL*, H. A. A74-18987
RAS*IAMOV, W. A. On the modes of icing of symmetrical lifting surfaces	A method of calculating the flow around a wing of arbitrary planform, positioned on a cylindrical body
KEDDIE, A. W. C. A74-18987	1711-19672
Relative air pollution emissions from an airport in the UK and neighbouring urban areas	REARER, C. Improvement of the downflow conditions behind an integrated shrouded propeller
KELLEY, H. J. N74-14282	KREMER, R. L. A74-17801
Differential-turning optimality criteria [AIAA PAPER 74-23] KERN, J.	Ultrasonic inspection of titanium airframe components
Aviation fuels and lubricants	KRETZ, H. A74-16479
KERR, C., JR. STOL tactical aircraft investigation. Volume 6:	March 1971 wind tunnel tests of the Dorand DH 2011 jet flap rotor, volume 1
Air cushion and ground mobility study [AD-767300] N74-13736	[NASA-CR-114693] N74-13722 Barch 1971 wind tunnel tests of the Dorand DB 2011
KERR, R. I. Optimisation of aircraft structures with multiple	jet flap motor, volume 2 NASA-CR-114694 N74-13723
stiffness requirements N74-15612	A sailplane wing constructed of foam core and polyester fiberglass skin
RESSLER, T. J. A color schlieren system	(AIAA PAPER 74-258) A74-18665
RHRAPOVITSKII, V. G. A74-17806	Automatic control aspects of a control-configured
Calculation of the aerodynamic characteristics of a wing system moving at subsonic speed near land or smooth water surface	aircraft with allowance for maneuver load control [DGLR PAPER 73-121] A74-17216 EUENKLER, E.
RIBREBUSCH, B. A74-18681	Problem of adapting an intake to a turbojet engine for extremely high flight mach numbers
A Bethod of designing supercritical lift profiles	KUROTO, V. H. A74-17272
KING, R. R. Engineering appraisal of Southwest Research	STOL tactical aircraft investigation, externally blown flap, Volume 5, part 3: Stability and control derivative accuracy requirements and
Institute magnetic crack definer applied to CH47 rotor blades	effects of Augmentation system design
[AD-769068] N74-14778 KIRK, C. L.	KUHKBL, B. A.
Random vibration with non-linear damping KITAGAWA, T. A74-18297	Thermal and chemical fog dissipation: Results of field experiments at Vandenberg AFB, California during July 1972
An aircraft exterior coating system and surface	[AD-768671] N74-15367
pretreatment A74-17862	Blade dynamics analysis using WASTRAM
KLBIN, S. W. Aircraft force protection model. Volume 1: Users quide to APPN	KUZEETSOV, N. D. The problem of optimal design of gas-turbine engines
[AD-767946] N74-13751 KLINEBERG, J. H.	A74-18083
Calculation of separated flows at subsonic and transonic speeds	I DOED D .
KORNIG, D. G. A74-16965	LA ROSE, R. L. Application of damage tolerance technology to
wind tunnel investigation of a large-scale 25 deg swept-wing jet transport model with an external	advanced metallic fighter wing structure [AIAA PAPER 74-29] A74-18738 LAKSHHIYARAYAMA, B.
blowing triple-slotted flap (NASA-TH-X-62197] N74-13721	Characteristics of the wake behind a cascade of airfoils
Investigations concerning wingsfureless	17a-17495
interference in the case of subsonic velocity KONHERD, W. A74-18897	LANGEPELD, N. Supersonic flow past sharp- and blunt-nosed conical bodies at angles of attack from 0 to 45
On the problem of rain erosion on a moving body flying at supersonic speed	deq DGLR PAPER 73-080 A74-17186
A74-16727	Harch 1971 wind tunnel tests of the Dorand DH 2011
	Jet Ilap Fotor, Volume 1
	[NASA-CR-114693] N74-13722

		TTANK W	
March 1971 wind tunnel tests of the Dorand	1 DH 2011	Design and development support for critica	1
jet flap motor, volume 2 [NASA-CR-114694]	N74-13723	helicopter applications in Ti-6Al-4V all	oy
LATEL, V. IU.			174-16448
Heat transfer investigation in a bigh-tem;	erature	LIBBY, P. A.	iosl
qas flow spreading over a plane surface	1.74 AACOB	Technical evaluation report on AGARD Techn Meeting on Atmospheric Pollution by Airc	raft
	A74-18684	Engines	Luli
LAUDEBAN, E. C. STOL tactical aircraft investigation. Vol	lume 2:	[AGARD-AR-63]	N74-15349
Design compendium		LINCE, U. E. D.	
[AD-767561]	¥74-13733	Two numerical methods to solve realistic	
STOL tactical aircraft investigation. Vol	Lume 4:	air-to-air combat differential qames [AIAA PAPER 74-22]	A74-18736
Wind tunnel data analysis	N74-13734	LISTON, B. A.	p. , , , , , , ,
[AD-767363] LAUGHREY, J. A.	774-12124	Operational evaluation of the 5K-5 air cus	hion
Assessment of the influence of inlet and		vehicle in Alaska	
aftbody/nozzle performance on total airc	craft drag	[AD-768781]	N74-14772
	N74-14726	LIU, D. T. In-flight stabilization of externally slun	ıa
LAWSON, T. V. Problems of chemical pollution by aircraft	t. The	helicopter loads	7
airport and its immediate environment	,	[AD-769C63]	N74-14774
arrest and are realist or the second	N74-14281	LOECHELT, E.	
LAZENBY, S. D.		Structural materials of aeronautics and as	A74-18190
Lasers - Hanger and marked target seeker	A74-16756	LOBBE, R.	1111
LE BEERE, P.	H14-10150	The jet-flapped wing in ground proximity w	ith
Temperature, winds, and turbulence at SST	flight	special allowance for large angle of att	
levels		large jet flap angle	A74-17221
	<u> 174-17311</u>	CORD E 1	A / 4- 1 / 2 2 1
LBATHAM, A. L. Two numerical methods to solve realistic		LORD, H. J. Oltrasonic inspection of titanium alrframe	<u></u>
air-to-air combat differential games		components	
[AIAA PAPBR 74-22]	174-18736		A74-16479
LECLAIRE, R. C.		LORSON, E. W. A pylon to decrease the effects of externa	1 etores
LDF powered balloom program [AD-768673]	N74-14770	on the stability of aircraft	I Stores
LRB, R.	M74-14770	[AD-767913]	R74-13749
Noise and emission outlook for military ex		LOVE, J. E.	_
[AIAA PAPER 73-1156]	174-17175	Flight study of a vehicle operational stat	us and
LEFEBURE, A. E.	na1	monitoring system [NASA-TN-D-7546]	N74-13725
A preliminary study on the influence of for staging on nitric oxide emissions from		LUDWIG, L. P.	
turbine combustors		Improved circumferential shaft seal for ai	rcraft
	ม74-14301	qear transmissions	R74-14138
A proposed method for calculating film-co	oled wall	[NASA-TN-D-7130] LUKHANIN, V. B.	M/4-14 136
temperatures in que turbine combustion ([CRANFIELD-SHE-4]	N74-14440	An algorithm for rational selection of the)
LEHRAS, G. H.	*** *****	parameters of nonlinearly deforming thin	
Development of a graphite horizontal stab		framework elements	A74-18645
[AD-768869]	N74-14783	LUBDR, T.	R74-18043
LBISS, P. Flight control		Bigh cycle fatique properties of titanium	in
111400 000000	A74-18181	aircraft application	
LELAND, T. J. W.			174-16513
Recent studies of tire braking performance	e 176.47000	LUSARDI, R. J The determination of non-symmetric wehicle	•
THESTORY 1 T	A74-17898	stability parameters from response data	•
Transmission thermal mapping (CH-47C forward)	ard rotor	Doubland, Passacount that are are	N74-13792
transmission)		LUTZ, O.	
[AD-767875]	974-13732	Propulsion system installations	170-10170
LEMON, G. H. Study of structural criteria for composite	•	LUU, TS.	174-18179
airframes, Volume 1: Evaluation	~	Development of a method of	
[AD-767706]	N74-14238	discretized-distribution singularities f	
Study of structural criteria for composit		study of compressible and incompressible	flows A74-16968
airframes, Volume 2: Current/criteria rationale review and evaluation	/selected		. A14-10300
[AD-767707]	x74-14239	14	
LERNING, G. A.		M	
Plat rolled beta titanium alloys for airf	rame	MACWILKINSON, D. G.	-1:61-
application	A74-16449	A survey of drag prediction techniques app to subsonic and transonic aircraft design	
LESTER, B. C.	A74 10443	to Educate and citabolic dilotate acore	"H74-14711
An improved exceedance theory for combine		HADELAIRE, G.	
stresses with application to aircraft q	ust	Particle sampling and size analysis in the	
response	N79-14569	ejection zone of the Olympus jet engine ground level	at
LEVINSKI, E. S.	317-14303	droams roser	A74-17396
STOL tactical aircraft investigation. Vo	lume 2:	HAGHUS, R.	
Design compendium	w3/4 43555	Transonic drag due to lift of planar jet-f	ilapped
[AD-767561]	H74-13733	airfoils	N74-14720
LBVISON, W. H. Tactile display for aircraft control		MARAR, E. B.	21- 14120
(AD-767763)	N74-13741	Engineering evaluation of age life extensi	
LEYNAERT, J.		harnesses, risers and T-10 troop chest i	
Aerodynamic aspects of the problems of ai	r-iptakes	parachute canopies. Supplement 1: 1964	- 1305
and exhaust for a supersonic transport	aircraft	year classes	

#355454 - "			
Bakashov, E. H.		MIKUS, T.	
Calculation and analysis of aircraft motion [NASA-TT-P-757]	N74-14751	Parameters controlling nitric oxide emissi	ons from
MANNING, S. D.	874-14751	qas turbine combustors	* N74-14291
Study of structural criteria for composite	2	MILLER, G.	
airframes, Volume 1: Evaluation		Similarity parameters and their sensitivit	y for
[AD-767706]	N74-14238	transonic airframe exhaust nozzle intera	ctions
Study of structural criteria for composite	±	[AD-768908]	N74-14746
airframes, Volume 2: Current/criteria, rationale review and evaluation	selected	MITCHELL, J. T.	•
[AD-767707]	N74-14239	The ac power controllers for solid state	,
MARCHIONNA, N. R.	H74-14239	distribution system, Volume 1: Design,	
The effect of water injection on mitric or	ride	development, fabrication, and test of hy devices	DEIG
emissions of a gas turbine combustor bur	ning	[AD-768199]	N74-13903
ASTM Jet-A fuel		MIYAMOTO, Y.	N 14-13533
[NASA-TM-X-2958]	N74-14650	Ground operation tests of flying test had	for WTOL
Effect of water injection on mitric oxide		aircraft at National Aerospace Laborator	T
emissions of a gas turbine combustor but	rning	[NAL-TR-319]	N74-14764
natural gas fuel [NASA-TH-X-2959]	W85 45454	HEHITARIAN, A. M.	
Effect of increased fuel temperature on en	N74-14651	On the modes of icing of symmetrical lifti	ВĢ
of oxides of mitrogen from a gas turbine	ILESIONS	surfaces	
combustor burning ASTM jet-A fuel	•	HOKRY, H	A74-18987
[NASA-TM-X-2931]	ж74-15659	Integral equation method for calculation o	•
MARCHMAN, J. P., III		subsonic flow past airfoils in a ventila	I Andreina
Vortex age as a wake turbulence scaling pa	ırameter	tunnel - Comparison with MAE high Reynol	teu Wing
[AIAA PAPER 74-36]	A74-18745	number measurements	up
BABSHALL, J. R.		[AIAA PAPER 74-83]	A74-18764
Vortex age as a wake turbulence scaling pa		HOLINIER, B.	
[AIAA PAPER 74-36] MATRAND, C.	A74-18745	Development of cold headable titanium allo	ys for
	-9.4.49	the 'Concorde' supersonic jet	
Drag of lifting bodies for pilots at high	N74-14731	MOTOCOWDDY B o	A74-16554
MAURER, R. S.	M/4-14/31	MOUTGOMERY, R. C.	_
Skylacking and airport security		A self-reorganizing digital flight control for aircraft	system
	A74-18100	(AIAA PAPER 74-21)	174-19900
MAYES, D. J.		HOOB, L. P.	A74-18808
The impact of area navigation on flight co	ntrol	Jet noise modeling - Experimental study an	a febom b
systems and displays		for the noise and turbulence fields	
MATERIA C C	A74-17277	[AIAA PAPER 74-3]	A74-18723
MATERS, S. C.		MORIN, S.	-
A real-time digital program for estimating aircraft stability and control parameter	6	User's manual for ILSLOC: Simulation for	
flight test data by using the maximum li	s irom kalikaad	derogation effects on the localizer port	ion of
method	Wellinoon.	the instrument landing system [AD-768049]	
[NASA-TM-X-2788]	N74-13882	HORRIS, G. J.	N74-14361
MAYME, A. W., JR.		Improved silicone fluids as candidate gas	tarbino
Calculation of the boundary-layer flow in	the	engine oils for minus 40 P to 465 F temp	curbine erature
windward symmetry plane of a spherically	blunted	range	cracare
axisymmetric body at angle of attack, in	cludinq	[1D-767898]	N74-14246
stream line-swallowing effects		HORRIS, R. L.	
HAYO, H. G.	N74-13992	The influence of wing loading on turbofan	powered
Q-PANSTM for general aviation aircraft		STOL transports with and without external	11 y
	N74-13726	blown flaps [NASA-CR-2320]	
NCCARTY, J. B.		MOSBR, A.	N74-13718
Analytical and experimental investigation	of	Inviscid wake-airfoil interaction on multic	alexent
aircraft metal structures reinforced wit	b	high lift systems	ereaenc
filamentary composites. Phase 3: Major		, -,	A74-18143
component development		MOZER, M.	417 10143
(NASA-CR-21227 MCCARTY, J. L.	N74-14625	A new ILS localizer for regional airports	
Recent studies of tire braking performance			174-18901
Recent Studies of tite blaking periormance		NUBLIER, R.	
BCHOGH, P. J.	174-17898	Investigations concerning wing-fuselage	
V/STOL tilt rotor aircraft study. Volume	10+	interference in the case of subsonic velo	
Performance and stability test of 1 1-14	622	MULLER, J.	A74-18897
Froude scaled Boeing Vertol Model 222 ti	lt rotor	The Bole balloons and air safety	
aircraft (Phase 1)		and mare parisons and all Salety	A74-18596
[NASA-CR-114603]	N74-13727	MULLOWNEY, P. E., JR.	A /4- 10350
BEDAN, R. T.		The design, fabrication and evaluation of t	the
Plotting program for aerodynamic lifting so theory	urface	aural angle of attack/stall warning syste	en e
[NASA-TH-X-62321]		[AD-767663]	N74-13748
MRISENBURG, B.	N74-14739	MUNCA, C. L.	
Supersonic fuels from medium oils produced	hm 44-	Isolated airfoil - TIP worter interaction r	
thermal cracking of crude oil residues	ny toe	[AIAA PAPER 74-194]	A74-18831
[DFVLR-SONDDR-301]	A74-18925	MURHAN, E. M.	
MELZER, V.		A relaxation method for calculating transor	ic
Some results of an experimental study of the	he	flows with detached bow shocks	
Rerodyne concept by Dornier System GmbH	-	EUTTER, H.	A74-16970
IDGLE PAPER 73-0693	A74-17178	V/STOL tilt rotor aircraft study. Volume 1	10:
HENNIE, D.		Performance and stability test of a 1-10.	622
Military and aerospace		Froude scaled Boeing Vertol Model 222 til	t rotor
BICALE, B. C.	A74-18050	aircraft (Phase 1)	
Dynamics of slung bodies utilizing a rotati		[NASA-CR-114603]	N74-13727
wheel for stability	1114		

A74-18141

Table 10 and prospects for development and prospects for development of cotary-risp altered? 18107, N. 1. 18107, N. 1. 18108, J. 7. 18109, M. 1. 18100, M. 1. 18109, M. 1. 18100,	HYERS, R. R.	t a n	oppsmers, a. a. factors controlling pollutant emissions from	om qas
STORT, B. 1. The the control of the terms of the control of the co	Turning characteristics of the Bell 100 to	ton	turbine engines	
National continuous to the basis of the treatment and against not treatment thanking against not treatment to again the proposed t	'[AD-767680]	N74-13753	ORMISTON, R. A.	*****
N Inc. P Analyzin of statistical data	Some current problems and prospects for	A74-18641	Helicopter modelling /18th Henson and Stri	V.d. 10140
N ***ISS. 7.** **Ashirst of flow-reversal delay for a pitchina shirst of flow-reversal delay for a pitchina (AIAA PAPE 74-83) A74-18815 **BLEER, 8. 7.* **Ashirst of flow-reversal delay for a pitchina (AIAA PAPE 74-83) A74-18815 **BLEER, 8. 7.* **BLEON, 8. C.* **Are-loose and accounts suppressors of fass of high bysass turbofan enginess turbofan e	helicopters on the basis of the treats	light ent and	Lecture/	A74-1B299
Nativation of flow-reversal dular for a pitching flight, and the property of t		A74-18694	P	
Alsalvate of flow-reversal delay for a pitching [AllA PAPER 74-183] [AllA PAPER 74-183] [AllA PAPER 74-183] [AllA PAPER 74-183] [All PAPER 74-183]			PADBERG, D. J. Fretting resistant coatings for titanium a	11oys
Airfold [AIA PAPER 74-183] [AIA	Mise, J. P.	tchina	PAINTER, W. D.	R14 (0332
Pales, P. I. Secondary and constructions and test of accountic suppressors for face of high bypass trubofan endines [VA3A-C-1338] W74-13724 Hardy and the part place for angles of attack up to 180 degrees and assentes on a slender body with a jet place for angles of attack up to 180 degrees and assentes on a slender body with a jet place for angles of attack up to 180 degrees and assentes and assentes of a suppressor of the assentes of a suppressor of a terriboprop engine turbine deader system of a terriboprop engine turbine of allitary sistions of silitary sistions of silitary sistions of silitary sistions of a suppressor of a terriboprop engine turbine of silitary sistions of decoration effects on the localizer portion of decoration effects on the localizer portion of the instrument landing system of the instrument l	airfoil [AIAA PAPER 74-183]		HPL-10 lifting body flight control system characteristics and operational experien	ce N74-14753
turbofan endines W78-13724 MRS WAR-C-2385] Marcodynamic forces and assents on a slender body with a jet pluse for angles of attack up to 180 coreces of a term of the degrees of the flow about delta wings with leading edge separation at supernosic speeds. War-14725 WRS WAR-C-123250] WAR-T-123250] WAR	Developmental design, fabrication, and t	est of bypass	nevelopmental design, fabrication, and tes	t of
Nerodynamic forces and societé on a slender body with a jet pluse for anales of attack up to 198 degrees REBIL, J. P. Analysis of the flow about delts wings with leading dede reperation at supersonic spends INTERNAL vaircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and opportunities for reduction without inhibition of sillitary aircraft and airport noise and noise and control of the inhibition of sillitary aircraft and airport noise and analyze of the inhibition of sillitary aircraft and airport noise aircraft and airport noise and approach to air noise aircraft aircraft air sillitary aircraft and airport noise aircraft authorior of sillitary noise aircraft authorior of sillitary noise aircraft authorior of engine erhaust products by trailing vortices for supersonic filitary aircraft departure divergence filitary aircraft departure divergence filitary aircraft departure divergence criteria with a sin-degree of-freedon distint situation program aircraft during vind tunnel noise seasurements of a province of	turbofan engines [NASA-CR-2338]		turbofan engines	
PRENDIT, J. P. Analysis of the flow about delta wings with leading dedge separation at supernonic speeds. The leading of all littery aircraft and disports notice of sing loading on turbofan powered and intervenent leading system. The leading system and location of the instrument leading system. The location and supernonic toward optimizing saterial cost and speroact toward optimizing saterial cost and products by trailing vortices for supersonic products by trail	Aerodynamic forces and moments on a slen with a jet plume for angles of attack	der body up to 180	a ctude of the combined vibrations of the	turbine
halysis of the flow about delta wings with leading edge separation at superconoic speeds [RASA-CR-132350] R74-14745 BYTERIF J. B. STEDRIF, 2. B. STEDRIF, 2. B. STEDRIF, 2. B. STEDRIF, 2. B. STEDRIF, 3. B. STEDRIF, 3	[AIAA PAPER 74-110]	A74-18776		
### PASSETT I. B. ### PASSETT	Analysis of the flow about delta wings w leading edge separation at supersonic	speeds	Relative air pollution emissions from an a	irport
Military aircraft and airport noise and opportunities for reduction without inhibition of silitary aissions of silitary aissions (1 silitary aissions) N74-13752 NFERENT 21637/0631 BESSON D. BESSON D. SERVING A. SERVIN		N /4- 14 /45		N74-14282
[PB-23637/OGA] EVENDA, B. I. An innovative approach to airport planning A74-18099 EVENDA, D. Georgation effects on the localizer portion of the instrument landing system [AD-766099] AIGEOLS, E. S. An approach toward optimizing material cost and part function in advanced powerplants products by training vortices for supersonic flight in the stratosphore [AIAM PAPER 74-194] AISSET, J. E. Transonic transport winds - Oblique or swept Transonic transport winds - Oblique or swept incidence and cost [AD-768307] OSTITING, R. B. Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flam asceni-span wing with an upper-surface blown-flam asceni-span wing with an upper-surface blown-flam A74-18032 A74-18032 BINESCUR. J. A74-18032 A74-1803	Military aircraft and airport noise and opportunities for reduction without in		The influence of wing loading on turbolan STOL transports with and without externa	powered
ISSON, D. S.	[PB-223637/0GA]		[NASA-CR-2320]	N74-13718
derogation effects on the localizer portion of derogation effects on the localizer portion of the instrument landing system [AD-768049] N74-14361 NREDIS, N. S.	RRESON. D.	A /4- 18099	Isolated airfoil - TIP wortex interaction [AIAA PAPER 74-194]	noise A74-18831
ILCROID. B. S. S. An approach toward optimizing material cost and part function in advanced powerplants 174-1755 1812 PAPPR 730905 1812 PA	derogation effects on the localizer po	or ortion of	Lift-induced wing-tip vortex attenuation [AIAA PAPER 74-38]	A74-18852
An approach toward optizizing material cost and part function in advanced powerplants [SAP PAPER 730909] NIELSER, J. H. Indestion and dispersion of enqine exhaust products by trailing vortices for supersonic flight in the stratosphere [AIAH PAPER 74-82] NISSBET, J. W. Transonic transport winds - Oblique or swept NIVER, J. I. Orientation-error accidents in regular Army UB-1 aircraft during fiscal year 1970: Relative incidence and cost [AD-768307] OBTTING, R. B. Preliminary wind tunnel noise measurements of a sesi-span wing with an upper-surface blown-flap [AIAH PAPER 74-191] OGAMA, T. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] OLERBERD, J. B. Methods for reducing vibrations of equipment mounted on helicopter external stores stations [AD-768774] OLERBERD, J. B. Noise burden factor - New way of rating airport noise ONO, K. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] ORO, K. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] ONO, K. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] ONO, K. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] ONO, K. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] NATIONAL TRANSON [ANL-TR-319] ONO, K. Ground operation tests of flying test bed for WTOL aircraft at National Aerospace Laboratory [ANL-TR-319] NATIONAL TRANSON [ANL-TR-319] NATIONAL TRA	[AD-768049] RICHOLS, R. S.		a survey of drag prediction techniques app	olicable
Supersonic copressor test facility Indestion and dispersion of enqine exhaust products by trailing vortices for supersonic flight in the stratosphore flight	An approach toward optimizing material of part function in advanced powerplants			"N74-14711
products by trailing vortices for supersonic flight in the stratosphere [AITA PAPER 74-42] NISBET, J. W. Transonic transport wings - Oblique or swept Transonic transport wings - Oblique or swept A74-17048 NATH-17048 NATH-18082	BIELSEN, J. B.		Supersonic compressor test facility	174-18603
ITAM PAPER 74-82] NISBET, J. W. NISBET, J. W. Orientation-error accidents in regular Army UB-1 aircraft during fiscal year 1970: Relative incidence and cost [AD-768307] OBTIING, B. B. Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap semi-span wing with an upper-surface blown-flap (AILM PAPER 74-191] OGANA, T. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [MAL-TR-319] OLIVER, J. B. Noise burden factor - New way of rating airport noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory noise N74-16698 ONO, K. Ground operation tests of flying test bed for	products by trailing vortices for supe	ersonic	ryalmation of aircraft departure divergend	ce
### Transonic transport wings - Oblique or Sweth ### A74-17048 ###################################	[AIAA PAPER 74-42]	<u> 274-18815</u>	criteria with a six-degree-of-freedom d: simulation program	idital
Orientation-error accidents in regular Army UB-1 aircraft during fiscal year 1970: Relative incidence and cost [AD-768307] ORTING, R. B. Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] OGANA, T. Ground operation tests of flying test bed for VTOL aircraft at Mational Aerospace Laboratory [NAL-TR-319] OLIVER, J. B. Noise burden factor - New way of rating airport noise ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191 ORO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191 ORO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191 NAT4-14764 NAT4-14764 NAT4-14764 NAT4-14764 NAT4-14764 PRESIBIR, A. P. Bepresentation of hot jet turbulence by means of its infrared emission (NAS-TT-F-15233) NAT4-14363 PRELIPS, J. R. Performance of a ballute decelerator towed behind a jet airplane (NAS-TT-S-560191) NAT4-14764 PRESIBIR, A. P. STOL tactical aircraft investigation, externally blown flap, Volume 5, part 1: Control system mechanization trade studies [AD-767181] PICKESTT, R. G. Ground contamination by fuel jettisoned from aircraft NAT4-14283 PILIBIR, A. P. Experimental study of metal-plastic couplings in tension A74-18684 PREPULIT, H. Representation of hot jet turbulence by means of its infrared emission (NAS-TT-F-15233) NAT4-14363 PRELIPS, J. R. STOL tactical aircraft investigation, externally blown flap, Volume 5, part 1: Control system mechanization trade studies [AD-767181] PICKESTT, R. G. Ground contamination by fuel jettisoned from aircraft NAT4-14283 PILIBIR, A. P. Experimental investigation of glass-plastic and metal-plastic toints under shear	Transonic transport wings - Oblique or	swept 174-17048	PREALTA, B.	A74-18882
aircraft during fiscal year 1970: Relative incidence and cost [AD-768307] OBTILMG, R. B. OBTILMG, R. B. Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] OGANA, T. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] OLIVER, J. B. Noise burden factor - New way of rating airport noise ORO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ORO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ORO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] Experimental study of metal-plastic couplings in tension [NAL-TR-319] Experimental investigation of glass-plastic and external plastic toints under shear	oriontation-error accidents in regular :	Army UH-5	hydrotreating	17 <i>h</i> 1070U
Q OBTTING, R. B. Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [ATAL PAPER 74-191] OGANA, T. Ground operation tests of flying test bed for VTOL aircraft at Mational Aerospace Laboratory [NAL-TR-319] OLIVER, J. B. Methods for reducing vibrations of equipment mounted on helicopter external stores stations [AD-766774] OLLEBBEAD, J. B. Noise burden factor - New way of rating airport noise A74-1698 OHO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] OHO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] OHO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] M74-14764 Experimental investigation of glass-plastic and metal-plastic joints under shear	aircraft during fiscal year 1970: Re.	Tative	PRESHIM. A. P.	
OBTTING, R. B. Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] OGAWA, T. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] OLIVER EAD, J. B. Noise burden factor - New way of rating airport noise ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] ONO, K. Ground operation of hot jet turbulence by means of its infrared emission [NAL-TR-15233] NAL-14764 NAL-TR-1971 NAL-14764 NAL-TR-1972 NAL-TR-1972 NAL-14764 STOL tactical aircraft investigation of hot	1	874 - 13742	gas flow spreading over a plane surface	
Preliminary wind tunnel noise measurements of a semi-span wing with an upper-surface blown-flap [AIAA PAPER 74-191] A.74-18648 GENUAL TR-3191 A.74-18648 OLIVER, J. B. Noise burden factor - New way of rating airport noise ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191) N74-14764 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191) N74-14764 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191) N74-14764 Experimental study of metal-plastic couplings in tension A74-18648 Experimental investigation of glass-plastic and metal-plastic joints under shear			PERULLI, H. Representation of hot jet turbulence by m	
[AIAP PAPER 74-191] OGANA, T. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] OLIVER, J. H. Methods for reducing vibrations of equipment mounted on helicopter external stores stations mounted on helicopter external stores stations [AD-768774] OLIBERBAD, J. B. Noise burden factor - New way of rating airport noise ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] N74-14764 Experimental study of metal-plastic couplings in tension A74-18648 Experimental investigation of glass-plastic and metal-plastic joints under shear	p-aliminary wind tunnel noise measureme	nts of a blown-flap	its infrared emission	
Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] OLIVBR, J. H. Methods for reducing vibrations of equipment mounted on helicopter external stores stations [AD-768774] OLIBREBAD, J. B. Noise burden factor - New way of rating airport noise ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-319] N74-14764 Experimental study of metal-plastic couplings in tension A74-18648 Experimental investigation of glass-plastic and metal-plastic joints under shear	[AIAA PAPER 74-191]	A./4-18832	Performance of a ballute decelerator towe	d behind
OLIVER, J. B. Nethods for reducing vibrations of equipment Bounted on helicopter external stores stations [AD-768774] OLIBRIBAD, J. B. Noise burden factor - New way of rating airport noise N74-16898 ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] STOL tectical aircraft investigation, externally blown flap. Volume 5, part 1: Control system mechanization trade studies N74-13756 Ground contamination by fuel jettisoned from aircraft N74-14283 PIL'NIK, A. F. Experimental study of metal-plastic couplings in tension A74-18648 Experimental investigation of glass-plastic and metal-plastic joints under shear	Ground operation tests of flying test be aircraft at Mational Aerospace Labora	tory	[NASA-TM-X-56019]	N74-14760
DULTERIED, J. B. Noise burden factor - New way of rating airport noise NONO, R. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] NOTA-14764 Experimental investigation of glass-plastic and metal-plastic joints under shear	OLIVER, J. H. Methods for reducing vibrations of equi	pment	STOL tactical aircraft investigation, ext blown flap. Volume 5, part 1: Control	system
Noise burden factor - New way of rating airport noise None	[ap-768774]	H74-14771	[AD-767181] PICKUBTT, R. G.	•
ONO, K. Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory (NAL-TR-3191 N74-14764 Experimental study of metal-plastic couplings in tension A74-18648 Experimental investigation of glass-plastic and metal-plastic joints under shear	Noise burden factor - New way of rating	airport	Ground contamination by fuel jettisoned f	
Ground operation tests of flying test bed for VTOL aircraft at National Aerospace Laboratory [NAL-TR-3191] N74-14764 Experimental study of metal-plastic couplings in tension A74-18648 Experimental investigation of glass-plastic and metal-plastic joints under shear	ROT 2c	A74-16898	DT1(27# & 9	р74-14283
[WAL-TR-319] N74-14/64 Experimental investigation of glass-plastic and	Ground operation tests of flying test b	tory	Experimental study of metal-plastic coupl	
		n74-14764	Experimental investigation of glass-plast metal-plastic joints under shear	ic and

			1
PIVOVAROV, V. A.			<i>i</i>
Life of fatique cracks on rotor blades o	f turbines	^	
in qas turbine engines [AD-767947]		· · · · · · · · · · · · · · · · · · ·	
PLATZER, H. P.	R74-14447	QUIGG, H. T.	
Theoretical investigation of supersonic	flow past	Reduction of pollutants from aircraft turb fuel selection and prevaporization	
oscillating cascades with subsonic lea	ding-edge	(AD-769099)	N74-1546
iocus (Aiaa Paper 74-14)	370 400b2	QUILICI, a.	
PLETT, E. G.	A74-18843	Porty years of civil aviation, 1931 - 1971	
Noise deneration by cylindrical spoilers	immersed	QDILLEVERE, A.	N74-1475
in an air duct		Emission of gaseous pollutants by turbojet	engines
[AD-767336] Research on noise generated by ducted ai	N74-1373º	- The Olympus case	01192200
combustion systems	t-inel		A74-1730
[AD-767337]	N74-14445		
PLONER, J. A.	_	R	
Analysis and calculation of lightning-in- goltages in aircraft electrical circui-	duced	RAAB, M.	
[NASA-CR-2349]	N74-14754	A new ILS localizer for regional airports	
POLI, C.		RABBE, A.	A74-1890
Dynamics of slung bodies utilizing a rota wheel for stability	ating	Aircraft components from remelted steels -	Design
and the bedselley	A74-18141	and development	
POLUSEKIN, Y. P.		RIJ, R,	A74-1788
Calculation and analysis of aircraft moti		Characteristics of the wake behind a casca	đe of
[NASA-TT-P-757] PONDHAREPF, N. A.	N74-14751	airfoils	uc or
STOL tactical aircraft investigation, vo	olume 4:	RAKBINOV, E.	A74-17495
Wind tunnel data analysis		Nonstationary vibrations of a rigidly supp	
[AD-767363] POPOY, Y. A.	N74-13734	flexible rotor of variable mass	ortea
Evaluation of the operations contained in	•		A74-17851
algorithms carried out by digital contr	roller	RAMBAUD, M. Aircraft components from remelted steels -	
computers		and development	Design
POSTLEBAITE, J. E.	174-18638		A74-17897
Exhaust system interaction program		BANSEY, J. C.	
[AD-769086]	N74-14747	STOL tactical aircraft investigation. Volumentum	1me 2:
POTHRER, R. D.		[AD-767561]	N74-13733
Multi-surface system for the CCV B-52 [AIAA PAPER 74-126]	A74-18851	STOL tactical aircraft investigation, Volume	18e 4:
Control Configured Vehicle Ride Control	CCV PCSI	Wind tunnel data analysis (AD-767363)	
B-32 COULTOI System analysis, synthesis	, and	HANDOLPH, R. E.	N74-13734
design [LD-767590]	N74-13728	Graphite composite landing gear components	- side
PRELEWICZ, D. A.		brace assembly and torque link for A37 B [AD-769041]	aircraft
Concepts for a theoretical and experiment	al study	RAVETTI, A.	N74-14779
of lifting rotor random loads and vibra (identification of lifting rotor system	tions	Buckling loads and minimum weight of compre	essed
parameters from transient response data	l. Phase	curved ribbed aluminum allow panels	
/- B	.,,	RAVIRE, E. H.	A74-16822
f NASA-CR-114710] PRICE, B.	N74-14758	Theory and practice of avionics reliability	,
STOL tactical aircraft investigation. Vo	10=0 5+		A74-18597
tridut control technology		RRY, E. S. Plotting program for aerodynamic lifting su	
[AD-767364] PRITT, H. L. T.	N74-13735	theory produce for derodynamic flifting St	rrace
Graphite composite landing gear component		[NASA-TH-X-62321]	N74-14739
brace assembly and torque link for \$37	s - side B aircraft	REHBACH, C.	
1 VD-1030411	N74-14779	Numerical investigation of vortex sheets is from a separation line near the leading e	suing
PROKHACH, E. E. Evaluation of the influence of errors in			199 174-18289
specifying boundary conditions on the a	Concer	HEICHERT, G.	
or the determination of temperature fie	lds in	Rotary-wing aircraft	
infinite cylinders		REID, T. P.	A74-18177
PRUSLIN, D. H.	174-18635	STOL tactical aircraft investigation. Volu	me 6:
Empirical assessment of ATCRBS		All Cushion and ground mobility study	
[ATC-16]	N74-15379	BRINSCH, W. A.	N74-13736
PUGH, P, G. The drag of externally carried stores: I		B-1 cost/weight trade methodology	
prediction and alleviation	ts		A74-16447
	N74-14729	REMSRIARR, D. J.	
PORDY, D. H.		STOL tactical aircraft investigation, exter blown flap. Volume 1: Configuration	
Development of a graphite horizontal stab:		derinition, Supplement 1: Aerodynamic tr	ades of
PILE, J. S.	N74-14783	114 and roll control system	
Review of drag measurements from flight to	ests of	STOL tactical aircraft investigation, exter	N74-13754
manned aircraft with comparisons to wind predictions	1-tunnel	prove riap, volume 3: Performance metho	ga ang
	N74-14735	landing rules	
Performance of a ballute decelerator towed	behind	[AD-767180] REVINOV, V. M.	N74-13755
a jet airplane [NASA-TM-X-56019]		Some current problems and prospects for	
* **** ** *- 200 12	N74-14760	development of rotary-wing aircraft	
			A74-18641

Determination of the basic parameters of l helicopters on the basis of the treatmen	ight t and	SAIDSBURY-CARTER, J. B. NASTRAN data generation of helicopter fusel	aqes
analysis of statistical data	A74-18694	using interactive graphics	N74-14621
REO. O.		SAITO, K. An aircraft exterior coating system and sur	face
Three-dimensional compressible boundary la over a waved come with mass injection		An aircraft exterior coating system and sor pretreatment	A74-17862
RIABCHENKO, V. H.	N74-13960	SALENANN, V.	
An algorithm for rational selection of the parameters of nonlinearly deforming thin	e n-walled	Exhaust system interaction program [AD-769086]	N74-14747
framework elements	A74-18645	SALMIRS, 5. Electronic displays and digital automatic of	ontrol
RICCIUS, B.		in advanced terminal area operations [AIAA PAPER 74-27]	A74-18861
Fixed wing aircraft	A74-18176	SALTZHAR, R. J.	f
RICE, C. B.		Review of drag measurements from flight tes manned aircraft with comparisons to wind-	tunnel
LDF powered balloom program [AD-768673]	N74-14770	predictions	N74-14735
RICHARDS, R. J.	rnort	SAMISIS, J. C.	
Noise burden factor - New way of rating at noise		graphite composite landing gear components	- side
	A74-16898	brace assembly and torque link for A37 B [AD-769041]	N74-14779
RICHARDSON, B. L. The refining of turbine fuels by modern		SANDERS, L. R. Titanium - The bridge to composites	
hydrotreating [AIAA PAPER 74-162]	174-18798		A74-16451
RIX, W. J. Models in the design of fuel systems		SAMDIFER, J. P. Evaluation of methods for reducing fretting	1
Models in the design of fuel systems	A74-16758	fatique damage in 2024-T3 aluminum lap jo	ints 1874-16696
ROBERTS, G. B. Relative air pollution emissions from an	airport	SAUNDHAN, R. A.	
in the UK and neighbouring urban areas		Tactile display for direraft control	¥74-13741
ECEHRS, R. J.	N74-14282	[AD-767763] SANTER, R. P.	
Ultrasonic inspection of titanium airfram	e	The hydrogen fuel economy and aircraft pro [AIAA PAPER 73-1319]	oulsion A74-17905
components	a74-16479	Pactors controlling pollutant emissions from	
ROFFE, G.		turbine engines	N74-14292
Similarity parameters and their sensitivitransonic airframe exhaust nozzle inter [AD-768988]	actions N74-14746	SAYER, B. J The use of ultra high strength titanium al:	loys in
ROGAN, J. E.	271 771.15	a Y/STOL military aircraft application - S. A. Harrier	The H
Ablation	A74-17103	S. A. Halliel	A74-16446
ROBLING, W. J.		SCHEBRER, J. A method of designing supercritical lift p	ofiles
The influence of wing loading on turbofan STOL transports with and without extern	ally	[DGLR PAPER 73-081] SCHIPP, L. B.	A74-17187
blown flaps [NASA-CR-2320]	N74-13718	Nonlinear aerodynamics of aircraft in	
ROOHRY, B. C. Development of techniques to measure in-f	liaht.	high-angle-of-attack maneuvers [AIAA PAPER 74-85]	A74-18765
drag of a US Navy fighter airplane and		A study of the nonlinear aerodynamics of b	odies in
correlation of flight measured drag wit	h wind	nonplanar motion [MASA-TR-R-421]	N74-14741
tunnel data	N74-14734	SCHRITT, V.	n
ROSS, D. H. Tactile display for aircraft control		Experimental study of the internal noise i injector driven wind tunnels	
[AD-767763]	N74-13741	[ONERA, TP NO. 1315]	A74-18288
RUDOLPH, F. P. Effects of Ti-6Al-4V allov metallurgical		SCHOBPER, W. Dynamic test of air data computers with si	mulated
structures on ultrasonic response chara	cteristics	fliqht profiles	A74-1773
RUBSTADLER, P. W., JR.	A74-16477	SCHULZ, D.	
Modeling a high pressure ratio centrifuga	7	Optimization and design of the rear fusela	
compressor using a low speed of sound q	30		qc or
PYLSKIT, G. I.	as N74-14444	the A 300 B aircraft structure	N74-1561
pright control of simplenes and helicopte	и74-14444 и74-14444	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle	N74-15614 ction
Plight control of airplanes and helicopte [AD-767943]	и74-14444 и74-14444	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle control system for the herodyne wingless	N74-1561
Plight control of airplanes and helicopte [AD-767943] EXHAVIN. L. 8.	as 174-14444 ers 174-13738	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle	N74-1561
Flight control of airplanes and helicopte [AD-767943] BZHAVIN. I. B. A study of the combined vibrations of the disk-blade system of a turboprop engine	as N74-14444 PF74-13738	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight ve [DGLR PAPER 73-070] SCHULZE, C.	N74-1561/ ction hicle A74-1717
Plight control of airplanes and helicopte [AD-767943] BZHAVIN, L. B. 1 study of the combined vibrations of the	as N74-14444 PF74-13738	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight ve [DGLR PAPER 73-070] SCHULZE, C. Designing with plastic resin matrix compos materials	N74-1561 ction hicle A74-1717
Flight control of airplanes and helicopte [AD-767943] BZHAVIN, L. B. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel	as	the A 300 B aircraft structure SCBULZ, U. Design and hower-flight testing of a defle control system for the herodyne wingless remote-controlled experimental flight we [DGLR PAPER 73-070] SCBULZE, C. Designing with plastic resin matrix compose materials [DGLR PAPER 73-086]	N74-1561 ction hicle A74-1717
Flight control of airplanes and helicopte [AD-767943] BZHAYIN, L. N. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel	as	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight very [DGLR PAPER 73-070] SCHULZE, C. Designing with plastic resin matrix composementals [DGLR PAPER 73-086] SCHURATH, U. Photo-oxidation of aircraft engine emission	N74-15614 ction hicle A74-1717 ite A74-1719
Flight control of airplanes and helicopte [AD-767943] BZHAVIN, L. B. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel SABADASE, V. P.	nas 174-14444 F74-13738 Sturbine 174-18088	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight ve [DGLR PAPER 73-070] SCHULZB, C. Designing with plastic resin matrix composematerials [DGLR PAPER 73-086] SCHURATH, U.	N74-15614 ction hicle A74-1717 ite A74-1719
Flight control of airplanes and helicopte [AD-767943] BZHATIN, L. N. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel	nas	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight ve [DGLR PAPER 73-070] SCHULZE, C. Designing with plastic resin matrix composematerials [DGLR PAPER 73-086] SCHURATH, U. Photo-oxidation of aircraft engine emission and high altitudes SCHUBLZER, G.	N74-1561 ction hicle A74-1717 ite A74-1719
Flight control of airplanes and helicoptes [AD-767943] BZHATIN, L. N. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel S SABADASH, V. P. Beat transfer investigation in a high-ten gas flow spreading over a plane surface	ms	the A 300 B aircraft structure SCHULZ, U. Design and hover-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight ve [DGLR PAPER 73-070] SCHULZE, C. Designing with plastic resin matrix compos materials [DGLR PAPER 73-086] SCHURATH, U. Photo-oxidation of aircraft engine emissic low and high altitudes	N74-1561 ction hicle A74-1717 ite A74-1719
Flight control of airplanes and helicoptes [AD-767943] BZHATIN, L. N. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel S SABADASH, V. P. Heat transfer investigation in a high-ten gas flow spreading over a plane surface SAGATA, S. An aircraft exterior coating system and s	ms	the A 300 B aircraft structure SCHULZ, U. Design and hower-flight testing of a deflet control system for the Aerodyne wingless remote-controlled experimental flight we [DGLR PAPER 73-070] SCHULZE, C. Designing with plastic resin matrix compost materials [DGLR PAPER 73-086] SCHURATH, U. Photo-oxidation of aircraft engine emission low and high altitudes SCHWEIZER, G. Plight control. SCIBILIA, H. F.	N74-1561/ ction hicle A74-1717/ ite A74-1719 ns at H74-1427
Flight control of airplanes and helicoptes [AD-767943] BZHATIN, L. N. A study of the combined vibrations of the disk-blade system of a turboprop engine wheel S SABADASH, V. P. Beat transfer investigation in a high-ten gas flow spreading over a plane surface	ms	the A 300 B aircraft structure SCHULZ, U. Design and hover-flight testing of a defle control system for the Aerodyne wingless remote-controlled experimental flight ve [DGLR PAPER 73-070] SCHULZE, C. Designing with plastic resin matrix compos materials [DGLR PAPER 73-086] SCHURATH, U. Photo-oxidation of aircraft engine emissic low and high altitudes SCHUEIZER, G. Plight control	N74-1561/ ction hicle A74-1717/ ite A74-1719 ns at H74-1427

CCDTGGG - "	
SCRUGGS, R. M.	SKYORCHEYSKII, E. A.
Analysis of flow-rewersal delay for a pitching airfoil	Some specific characteristics of small qus
•	turbines and the modeling problems of their wind tunnel testing
SERLMANN, H.	4 A74-18682
Plight control	SLETTEN, C. J.
\$74-	
SELLS, C. C. L. Calculation of the induced velocity field on an	Doppler filter/multi-element horn array
off the wing plane for a swept wing with give	SHITE, A. H. O.
load distribution	Remarks on methods for predicting viscous drag
[ARC-B/M-3725] N74-	1766 #74-14718
SEREPHIN, L.	SHITH, S. G.
Heat-resistant titanium alloys - Introduction o the 651 A alloy	Aircraft inertial system testing and evaluation in
A74-	the United Kingdom
SERGRANT, R. J.	891 SHITH, T. W.
Three dimensional supersonic flow field analysi	Minimum life cycle costing for a V/STOL transport
of the B-1 airplane by a finite difference	[3N=768133] NTB 43700
technique and comparison with experimental da fAIAA PAPER 74-1891	
SHAPIRO, M.	877 A preliminary design of a remotely-controlled glider for a long-line operation
New jumbo jets must speak in whispers - Certify	g [AD-767879] N74-13744
the Lockheed 1011	SMEDRER, R. S.
SHEFTEL, L. V.	
Calculation and analysis of aircraft motion	profiles and comparison with full-scale
[NASA-TT-P-757] N74-	experimental measurements 751 [AIAA PAPPR 74-39] 874-18767
SBIBOYA, A.	SORRUSON, J. D.
Ground operation tests of flying test bed for V	L Influence of boundary layer blowing on the
aircraft at National Aerospace Laboratory [NAL-TR-319]	low-speed aerodynamic performance of a 45 degree
N74- SHIVASHANKARA, B. W.	
Combustion generated noise in turbopropulsion	[AIAA PAPER 74-269] A74-18674 SOROKIW, W. G.
systems	Dynamic creep of titanium alloy with 1.5 wt % mn
[AD-760615] N74- SHOLLEMBERGER, C. A.	666 and 3% Al in high-velocity air streams
Inviscid wake-airfoil interaction on multielene	SPANNUTH, W. H.
high lift systems	L-1011 upkeep
A74-	143 [SAE PAPER 730883] A74-17532
SHORY, K. C. The ac power controllers for solid state	SPENGLER, G.
distribution system Volume 1: Design,	Aviation fuels and lubricants
development, fabrication, and test of hybrid	SPETER, J. L. A74-18180
devices [AD-768199]	On the fuel optimality of cruise
SIGALLA, A.	
The problem of installing a modern high bypass	SPEZIA, B. Orientation-error accidents in regular Army UH-1
engine on a twin jet transport aircraft	aircraft during fiscal year 1970: Relative
SILCOL, R. J.	727 incidence and cost
Wind tunnel dynamic analysis of an oscillating	[AD-768307] N74-13742
airtoil	The use of fully stressed iteration and structural
[AIAA PAPER 74-259] A74-	666 index in automated structural optimization
SILVERHAM, B. A.	174-17739
Thermal and chemical for dissipation: Results of field experiments at Vandenberg AFB, Californ	
during July 1972	Inquestion and dispersion of engine exhaust products by trailing vortices for supersonic
[AD-768671] N74-	367 flight in the stratosphere
SILVERHAM, P.	[AIAA PAPER 74-42] A74-18815
Vortex cases - At a turbulent crossroads	STARSES, P. B.
SIBBIRSKII, D. P.	
A film thermocouple with a platinum electrode for	STAVA. D. J.
thermometry of gas turbine engine blades	Assessment of the influence of inlet and
SIBKIBS, A. B. A74-1	artbody/nozzle performance on total aircraft drag
Production data package 267 gallon external fuel	STEGER, J. L. N74-14726
tank	Calculation of separated flows at subconic and
FAD-767937] H74-1 SINGLETON, R. R.	45 transonic speeds
Analysis of flow-reversal delay for a pitching	A74-16965
alrioil	STRINBERG, M. A. Baterials for the new generation of aircraft
[AIAA PAPER 74-183] 874-1	35 A74-17374
SIRIBIX, H. Drag and separation	STERWPELD, H., JR.
	A study of the effect of flight density and
SITTERLE, G. J. N74-1	22 background noise on V/STOL acceptability
HFL-10 lifting body flight control system	[NASA-CR-2197] N74-14765 STOCKDALE, C. R.
Characteristics and operational experience	Control Configured Vehicle Ride Control (CCV RCS)
HASA-TH-X-2956 N74-1	B-52 control system analysis, synthesis, and
I NASA-TE-I-2956] N74-1 SKOBSCHEVSRII, L. S.	design
NASA-TE-IZ-2956 N74-1 SKOBSCHEVSRII, L. S.: The testing of jet engines, chapters 5 and 6 [AD-768492] N74-1	design [AD-767590] 875tem analysis, synthesis, and
NASA-TR-I-2956 N74-1 SKUBSCHEVSRII, L. S The testing of jet engines, chapters 5 and 6 [AD-768492] N74-1 SKUJINS, O.	67 STOIBBR, R,
NASA-TE-IZ-2956 N74-1 SKOBSCHEVSRII, L. S.: The testing of jet engines, chapters 5 and 6 [AD-768492] N74-1	design [AD-767590] 874-13728

N74-13713

		THOURER, T. H.	
STORES, R. P. Aircraft inertial system testing and evaluat:	ion in	Aircraft force protection model, Volume	: Osers
the United Kingdom	74-14352	quide to APPH [AD-767946]	N74-13751
STRABLE, W. C.		TOBAK, H.	
Combustion generated noise in turbopropulsion systems	מ	Nonlinear aerodynamics of aircraft in high-angle-of-attack maneuvers	
	74-15666	(AIAA PAPER 74-851	A74-18765
STROM, T. H. Improved circumferential shaft seal for airc	raft	TOBIR, H. W. Electronic displays and digital automatic	control
gear transmissions		in advanced terminal area operations	A74-18881
(NASA-TN-D-7130) N STUSHUD, R. W.	74-14138	[AINA PAPER 74-27] TOCCI, R. C.	
An approach toward optimizing material cost	and	Transmission thermal mapping (CB-47C forward	rd rotor
part function in advanced powerplants [SAE PAPER 730909] A	74-17535	transmission) (AD-767875]	N74-13732
SULLIVAN, R. D.		TOMPRIMS, G. T., JR.	laine
A method of calculating aircraft wake veloci profiles and comparison with full-scale	tγ	The aftermath of a hijacking - Passenger of and insurance	
experimental measurements	70 40757	TOPOROV, V. G.	A74-1810
[AIAA PAPER 74-39] A SCHHERFIELD, R.	74-18747	An algorithm for rational selection of the	
Noise generation by cylindrical spoilers imm	ersed	parameters of nonlinearly deforming this framework elements	1-Walled
in an air duct [AD-767336] N	74-13730	Ildreadix of chemic	A74-18645
Research on noise generated by ducted air-fu	el	forishki, T. Ground operation tests of flying test bed	for VTOL
combustion systems [AD-767337]	74-14445	aircraft at Mational Aerospace Laborator	· y
SUMMERS, R. B. Application of the aerospace multiprocessor	to the	[NAL-TR-319] TOURNEHINE, G.	N74-1476
A-7D flight control system		A direct method for computing the steady	
[AD-768382] N SURBER, L. E.	74-14769	Mach number one past a given wing airfo	.1 174-1696:
Assessment of the influence of inlet and		TOBER, P. W.	
aftbody/nozzle performance on total aircra	ft drag 174-14726	Pollution control of airport engine test	N74-1428
SUTHERLAND, H. B.		TOWER, T. H.	
pata acquisition, processing, and control fo advanced aircraft	r	Noise generation by cylindrical spoilers in an air duct	
[SAE PAPER 730957] A	74-17542	[AD-767336]	H74-13730
The problem of installing a modern high bypa	ss	TRAN, C. T. Calculation of the dynamic characteristics	s of a
engine on a twin jet transport aircraft	174-14727	helicopter structure by the method of hi	ranch mode: 474-1829
SYRE, R.		TRICOT, R.	
Development of cold headable titanium alloys the 'Concorde' supersonic jet	s for	Heat-resistant titanium alloys - Introduct the 651 A alloy	
<u> </u>	74-16554		A74-1789
SZWARC, W. J. Wind tunnel dynamic analysis of an oscillati	nq	TRIGGS, T. J. Tactile display for aircraft control	
airfoil	74-18666	[AD-767763] TRIPOL'SKII, S. S.	N74-1374
[AIAA PAPER 74-259] A	174-10000	A study of the combined vibrations of the	
T .		disk-blade system of a turboprop engine wheel	turbine
TABAKOPP, W.			474-1808
Erosion prediction in turbomachinery due to environmental solid particles		TROUT, A. E. The effect of water injection on mitric o	xide
[AIAA PAPER 74-16]	79-18732	emissions of a gas turbine combustor bu	
TAIG, I. C. Optimisation of aircraft structures with mul	ltiple	ASTM Jet-A fuel [WASA-TM-X-2958]	N74-1465
stiffness requirements		Effect of water injection on mitric oxide	
TATTCANA W.	174-15612	emissions of a qas turbine combustor bu natural qas fuel	
Ground operation tests of flying test bed for	or VIOL	(NASA-TM-X-2959] TSUKADA, S.	N74-1465
aircraft at National Aerospace Laboratory [NAL-TR-319]	174-14764	An aircraft exterior coating system and s	urface
TABABE, T.	. TMA!	pretreatment	A74-1786
Ground operation tests of flying test bed for aircraft at National Aerospace Laboratory	JI VIUL	TSYBUL'NIK, I. W.	
1 1 2 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1	174-14764	Experimental study of metal-plastic coupl tension	ings in
TABNES, E. pew investigations for reducing the base dra	ag of		A74-1864
wings with a blunt trailing edge	474-14723	Experimental investigation of glass-plast metal-plastic joints under shear	ic and
TANHER R. B.	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	·	a74-1869
Tactile display for aircraft control	N74-13741	TUCKES, R. E. Developmental design, fabrication, and te	st of
Tapia. M. H.		acoustic suppressors for fans of high b	
Evaluation of the modified Bendix AAU 19A/A altimeter	AIMS	turbofan engines [NASA-CR-2338]	N74-1372
[AD-768722]	974-15115	TUGARINOV, A. S.	lados of
TAYLOR, R. P. Roise and emission outlook for military engineers.	ines	A study of the damageability of turbine b aircraft gas-turbine engines after oper	
[AIAA PAPBB 73-1156]	<u> </u>	running in	A74-1868
TRODOSIADIS, R. Development of a graphite horizontal stabil:	izer		A 7 7 - 1979
[AD-768869]	H74-14783		

TONG, C.		WELLS, R. D.	
Analysis of the flow about delta wings with leading edge separation at supersonic spe	1	Engineering evaluation of age life exte	osion, T-10
[NASA-CR-132358]	n74-14745	harnesses, risers and T-10 troop ches parachute canopies. Supplement 1: 19	t reserve
THOMEY, H.		Year classes	1905
Calculation of the dynamic characteristics helicopter structure by the method of bra		[AD-767711]	N74-13743
	A74-18291	WHITE, C. Failure modes, effects and criticality	amalweig
TYREE, L., JR.		(PMECA) of category III instrument la	πding
Refrigerated containerized transport for 'J	umbo¹	system with traveling: Wave localize	r antenna
•	A74-17007	[U1-840912-100] UHITB, L. B.	₩74-1538º
	,	STOL tactical aircraft investigation.	Volume 5:
V		Flight control technology	
VANETSOV, L. A.		[AD-767364] WHITE, W. P.	N74-13735
Suitability of using titanium pipelines in	the	Effect of compressibility on three-dimen	nsional
hydraulic systems of turbine engines	A74-18090	helicopter rotor blade flutter	
VANLENHER, E.		WHITHEY, C. A.	N74-13714
Aviation needs and public concerns		STOL tactical aircraft investigation.	Volume 4:
VANE, P. W.	N74-14749	Wind tunnel data analysis [AD-767363]	476 42226
A 300 B static and fatique tests		WICKLUND, E. J.	N74-13734
VERSLER, U. G.	A74~16755	Flight study of a vehicle operational s	tatus and
Dynamic creep of titanium alloy with 1.5 wt	# Mn	■Onitoring system {BASA-TN-D-7546}	N74-13725
and 3% Al in high-velocity air streams		WILKINSON, H. T.	
VELTER, E.	A74-16579	Structural analysis of light aircraft us	
Problems in data management for earth monit	oring	WILLIAMS, C. S.	N74-14594
Bissions	•	Aircraft velocity measurement through	
YENTRES, C. S.	A74-17205	radar-altimeter echo: A theoretical i	
Plutter computer program and lifting surface	e	WILSON, C. A.	N74-14119
theory with boundary layer [NASA-CR-136559]		The simulation and analysis of carrier 1	landings
VICKEBS, R. S.	X74-14707	using a monlinear pilot model [AD-767679]	
Airborne profiling of ice thickness using a	short	BILSON, R. E.	1974-13747
pulse radar		Static and dynamic helicopter airframe a	analysis
VICKI, P. J.	A74-17810	with Mastran	
Non-destructive inspection of titanium jet	engine	WINTER, K. G.	N74-14616
disks	3.70 4.60.00	Measurements of the drag of some charact	teristic
VIGLA, D.	A74-16480	<pre>aircraft excrescences immersed in turk boundary lawers</pre>	oulent
VIGLA, D. Particle sampling and size analysis in the		boundary layers	oulent N74-14719
VIGLA, D.		boundary layers	N74-14714
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level		boundary layers WITZEL, J. Graphite composite landing gear componen	N74-14714
VIGLA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W.	t 1,74-17306	boundary layers WITZEL, J. Graphite composite landing qear componen brace assembly and torque link for A37 [AD-769041]	N74-14714
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level	t 1,74-17306	boundary layers WITZEL, J Graphite composite landing qear componen brace assembly and torque link for A37 [AD-769041] WOODLET, D. R.	N74-14714 nts - side / B aircraft
VIGLA, D. Particle sampling and size analysis in the ejection zone of the Olympus jet engine as ground level VOGRL, J. W. New jumbo jets must speak in whispers - Cere the Lockheed 1911	t 174-17306 tifying 1874-17856	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920]	N74-14714 nts - side 7 B aircraft N74-14779
VIGLA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011	t 174-17306 tifying 1874-17856	boundary layers WITZEL, J Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLAED, H. W.	N74-14714 nts - side / B aircraft N74-14779
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certain the Lockheed 1011	t 174-17306 tifying 1874-17856	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WODDLET, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe	N74-14714 nts - side / B aircraft N74-14779
VIGLA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011	t 174-17306 tifying 1874-17856	boundary layers WITZEL, J. Graphite composite landing gear component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Beavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187]	N74-14714 nts - side / B aircraft N74-14779
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certain the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon	t 174-17306 tifying 1874-17856	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLET, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLAED, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLLET, J. P.	N74-14714 ots - side 7 B aircraft N74-14779 A74-17537 ed wing A74-18834
VIGIA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011 W WAGNER, S. M. Problems of estimating the drag of a helicon walnumget, R.	t 174-17306 tifying 1874-17856	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Indestion and dispersion of engine exhau	N74-14714 ots - side 'Baircraft N74-14779 A74-17537 ed wing A74-18834
VIGIA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1911 W VAGNER, S. N. Problems of estimating the drag of a helicon that the constant is a property of the constant in the drag of systems.	t	boundary layers NITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] NOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] NOOLAED, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] NOOLLEY, J. P. Inquestion and dispersion of engine exhaup products by trailing vortices for supeflight in the stratosphere	N74-14714 ats - side by B aircraft N74-14779 A74-17537 ad wing A74-18834 ast arsonic
VIGIA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certification Service Control of the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicontrol of the Lockheel of th	t A74-17306 tifying A74-17856 Oter A74-14715	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-82]	N74-14714 ots - side 'Baircraft N74-14779 A74-17537 ed wing A74-18834
VIGIA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cere the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon the Lockheel in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for	t A74-17306 tifying A74-17856 Oter 174-14715	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Beavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLLEY, J. P. Ingestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-42] WOORBEL, R.	N74-14714 ots - side y B aircraft N74-14779 A74-17537 ed wing A74-18834 est ersonic A74-18815
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon wallest, B. Innovations in ATC communication systems WATSON, A. User's manual for LLSLOC: Simulation for derogation effects on the localizer portice.	t A74-17306 tifying A74-17856 Oter A74-14715	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Industion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-02] BOROSEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665]	N74-14714 ots - side y B aircraft N74-14779 A74-17537 ed wing A74-18834 est ersonic A74-18815
VIGIA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. H. New jumbo jets must speak in whispers - Cere the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon wallength, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049]	t A74-17306 tifying A74-17856 Oter A74-14715	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] WOOLLEY, J. P. Ingestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-42] WOOLBEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665]	N74-14714 ots - side ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est ersonic A74-18815
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon wainess of estimating the drag of estimating the dra	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14784 On of	boundary layers WITZEL, J. Graphite composite landing qear component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Indestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-02] BOROSEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156]	N74-14714 ots - side ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est ersonic A74-18815
VIGLA, D. Particle sampling and size analysis in the efection zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon walled the continuous in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WEBER, H. STOL tactical aircraft investigation. Volume	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14784 On of	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WODDLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] WOOLLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-92] WOODBL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSBAN, J. E. Woise and emission outlook for military [AIAA PAPER 73-1156]	N74-14714 ots - side ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est rsonic A74-18815 N74-13726 engines
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine at ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon wallest. H. Innovations in ATC communication systems WATSON, A. User's manual for LISLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WEBER, H. STOL tactical aircraft investigation. Volume air cushion and ground mobility study [AD-767300]	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14784 On of	boundary layers WITZEL, J. Graphite composite landing qear component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Indestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-02] BOROSEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156]	N74-14714 ots - side ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est rsonic A74-18815 N74-13726 engines A74-17175
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon walled the continuous in ATC communication systems VATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WEBER, H. STOL tactical aircraft investigation. Volume air cushion and ground mobility study [AD-767300] WEDDEN, P. R.	t	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapper section [AIAA PAPER 74-187] WOOLLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-02] BOROBEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WOSSE and emission outlook for military [AIAA PAPER 73-1156] WOSST, W. Drag in hypersonic rarefied flow	N74-14714 ots - side ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est rsonic A74-18815 N74-13726 engines
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cere the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon wallwarder, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WBBER, H. STOL tactical aircraft investigation. Volume in Communication and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14715 A74-14361 De 6: A74-13736	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WODDLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapped section [AIAA PAPER 74-187] WOOLLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-92] WOODBL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSBAN, J. E. Woise and emission outlook for military [AIAA PAPER 73-1156]	N74-14714 ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est rsonic A74-18815 N74-13726 engines A74-17175
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certicle Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon walled the Lockheed 1911 WAINBRIGHT, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WEBER, H. STOL tactical aircraft investigation. Volume Air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-4y allogs.	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14715 A74-14361 Def 6: A74-13736	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapper section [AIAA PAPER 74-187] WOOLLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-92] WOODLEY, J. B. Q-PANSTH for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156] WORSHAM, J. B. Drag in hypersonic rarefied flow	N74-14714 ots - side ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est rsonic A74-18815 N74-13726 engines A74-17175
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon wallwarder, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WBBER, H. STOL tactical aircraft investigation. Volume Air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-4y alloy was presented.	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14715 A74-14361 Def 6: A74-13736	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Inquestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-02] BORDSEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156] TORST, W. Draq in hypersonic rarefied flow	N74-14714 Ots - side Ots - side Ots - side N74-14779 A74-17537 A74-18834 Ots - side A74-18834 Ots - side A74-18835 A74-18815 N74-13726 Regines A74-17175 N74-14736
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certicles the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon the Lockheed 1911 WAINNEIGHT, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WEBER, H. STOL tactical aircraft investigation. Volume Air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-4y alloy BEIBERG, J. A. Takeoff and landing performance and noise measurements of a deflected slipstream soo	t 274-17306 tifying 274-17856 274-14715 274-14715 274-14361 28 6: 274-13736	boundary layers WITZEL, J. Graphite composite landing qear component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLLEY, J. P. Indestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-82] WORDSEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156] WORST, W. Draq in hypersonic rarefied flow Y WAFPEE, H. L. T700 aims at low combat maintenance	N74-14714 ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 est rsonic A74-18815 N74-13726 engines A74-17175
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cere the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon wallows in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portic the instrument landing system [AD-768049] WEBER, H. STOL tactical aircraft investigation. Volume Air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-0v alloy measurements of a deflected slipstream STO airplane with interconnected propellers and analyses.	t 274-17306 tifying 274-17856 274-14715 274-14715 274-14361 28 6: 274-13736	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WOODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapper section [AIAA PAPER 74-187] WOOLLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-92] WOODLEY, J. B. Q-PANSTH for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156] WORSHAM, J. B. Drag in hypersonic rarefied flow	N74-14714 Ots - side Ots - side Ots - side N74-14779 A74-17537 A74-18834 Ots - side A74-18834 Ots - side A74-18835 A74-18815 N74-13726 Regines A74-17175 N74-14736
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certical aircraft investigation. Volume in strument landing system (AD-768049) WEBER, H. STOL tactical aircraft investigation. Volume in cushion and ground mobility study [AD-767300] WEDDBN, P. R. Design and development support for critical belicopter applications in Ti-6Al-4y alloy BEIBERG, J. A. Takeoff and landing performance and noise measurements of a deflected slipstream STO airplane with interconnected propellers and rotating cylinder flaps [NASA-TH-X-62320]	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14715 A74-14361 DE 6: A74-13736 A74-16448	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WODLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Inquestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-02] BOROSEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WONSEAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156] FORSHAM, J. E. Draq in hypersonic rarefied flow YAPPEE, H. L. T700 aims at low combat maintenance (AGGI, P. P. Dynamic stall [MASA-CR-136473]	N74-14714 ots - side 'B aircraft N74-14779 A74-17537 ed wing A74-18834 ersonic A74-18815 N74-13726 engines A74-17175 N74-14736
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon wallwarden, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WBBER, H. STOL tactical aircraft investigation. Volume Air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-4y alloy medical properties and the seasurements of a deflected slipstream STO airplane with interconnected propellers and rotating cylinder flaps [NASA-TM-1-62320] WEINSTEIL, A. I.	t A74-17306 tifying A74-17856 Oter A74-14715 A74-14715 A74-14361 De 6: A74-13736 A74-16448 A14-13720	boundary layers WITZEL, J. Graphite composite landing quar component brace assembly and torque link for A37 [AD-769041] WODDLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flapper section [AIAA PAPER 74-187] WOOLLEY, J. P. Inquestion and dispersion of engine exhaus products by trailing vortices for superflight in the stratosphere [AIAA PAPER 74-02] BOROBBL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. Noise and emission outlook for military [AIAA PAPER 73-1156] WEST, W. Drag in hypersonic rarefied flow Y WAPPER, M. L. T700 aims at low combat maintenance WAGGY, P. P. Dynamic stall [MASA-CR-136473] Magnus characteristics of arbitrary rotal	N74-14714 Ots - side Ots - side N74-14779 A74-17537 Ed wing A74-18834 Ersonic A74-18815 N74-13726 engines A74-17175 N74-14736 A74-18998 N74-18998 N74-13709 ting bodies
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine at ground level VOGEL, J. W. New jumbo jets must speak in whispers - Certification in the Lockheed 1011 WAGNER, S. M. Problems of estimating the drag of a helicon waller. WAINHRIGHT, H. Innovations in ATC communication systems WATSON, A. User's manual for LISLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WEBBER, H. STOL tactical aircraft investigation. Volume air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-4V alloy medicated and landing performance and noise measurements of a deflected slipstream STO airplane with interconnected propellers and rotating cylinder flaps [NASA-TM-I-62320] WEINSTRIN, A. I. Thermal and chemical fog dissipation: Resulting the state of the service of the	t 274-17306 tifying 274-17856 274-17856 274-14715 274-14715 274-14361 26 6: 274-13736 274-16448 214-13720 256 05	boundary layers WITZEL, J. Graphite composite landing qear component brace assembly and torque link for A37 [AD-769041] WODDLEY, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLEY, J. P. Inquestion and dispersion of engine exhau products by trailing vortices for supe flight in the stratosphere [AIAA PAPER 74-02] WOONED, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WONSHAM, J. E. Woise and emission outlook for military [AIAA PAPER 73-1156] WORST, W. Draq in hypersonic rarefied flow YAPPER, H. L. T700 aims at low combat maintenance (AGGY, P. F. Dynamic stall [MASA-CR-136473] Ragnus characteristics of arbitrary rota [AGARD-AG-171] WATES, B. C., JR.	N74-14714 ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 ersonic A74-18815 N74-13726 engines A74-17175 N74-14736 A74-18998 N74-13709 ting bodies N74-13710
VIGLA, D. Particle sampling and size analysis in the election zone of the Olympus jet engine as ground level VOGEL, J. W. New jumbo jets must speak in whispers - Cert the Lockheed 1911 WAGNER, S. M. Problems of estimating the drag of a helicon wallwarden, R. Innovations in ATC communication systems WATSON, A. User's manual for ILSLOC: Simulation for derogation effects on the localizer portice the instrument landing system [AD-768049] WBBER, H. STOL tactical aircraft investigation. Volume Air cushion and ground mobility study [AD-767300] WEDDEN, P. R. Design and development support for critical helicopter applications in Ti-6Al-4y alloy medical properties and the seasurements of a deflected slipstream STO airplane with interconnected propellers and rotating cylinder flaps [NASA-TM-1-62320] WEINSTEIL, A. I.	t 274-17306 tifying 274-17856 274-17856 274-14715 274-14715 274-14361 26 6: 274-13736 274-16448 214-13720 256 05	boundary layers WITZEL, J. Graphite composite landing qear component brace assembly and torque link for A37 [AD-769041] WODDLET, D. R. Heavy Lift Helicopter main engines [SAE PAPER 730920] WOOLARD, H. W. Thin-airfoil theory of an ejector-flappe section [AIAA PAPER 74-187] WOOLLET, J. P. Ingestion and dispersion of engine exhau products by trailing vortices for supeflight in the stratosphere [AIAA PAPER 74-42] WORDEL, R. Q-PANSTM for general aviation aircraft [MASA-CR-114665] WORSHAM, J. E. WOISE and emission outlook for military [AIAA PAPER 73-1156] WOSST, W. Drag in hypersonic rarefied flow Y WAPPER, M. L. T700 aims at low combat maintenance WAGGY, P. P. Dynamic stall [MASA-CR-136473] Magnus characteristics of arbitrary rota [AGARD-AG-171]	N74-14714 ots - side ots - side N74-14779 A74-17537 ed wing A74-18834 ersonic A74-18815 N74-13726 engines A74-17175 N74-14736 A74-18998 N74-13709 ting bodies N74-13710

YEALY, J. P.
Simplified Visual Approach Slope Indicator (VASI)

(AD-767901)

YIB, S. K.
Concepts for a theoretical and experimental study
of lifting rotor random loads and vibrations
(the effects of some rotor feedback systems on
rotor-body dynamics), Phase 7-A

[NASA-CR-114709]

N74-14757

YOSHIHARA, B.
Transonic drag due to lift of planar jet-flapped
airfoils

ZABOHOWSKI, L., JR.
Restraint procedures for cargo loaded in vehicles to be air transported [AD-768172] N74-13954
ZELAZNY, S. W.
Jet noise modeling - Experimental study and models for the noise and turbulence fields [AIAA PAPER 74-3] A74-18723
ZHIRROV, A. F.
Suitability of using titanium pipelines in the hydraulic systems of turbine engines A74-18090
ZOLEZZI, B. A.
An approach toward optimizing material cost and part function in advanced powerplants [SAE PAPER 730909] A74-17535
ZOWARS, D.
Transonic drag due to lift of planar jet-flapped airfoils N74-14720
ZWARNEVELD, J.
Comparison of various methods for calculating profile drag from pressure measurements in the near wake at subcritical speeds

N74-14721

CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Special Bibliography (Suppl. 43)

APRIL 1974

Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section.

1	•
AP PROJ. G101	DA-ARO (D) -124-G154
N74-15467	A74-18732
AP PROJ. 487T	DAAJ01-73-C-0533
N74-13728	g74-14778
AF PROJ. 643A	DAAJ02-70-C-0022
N74-13733	1374-14444
N74-13734	DAAJ02-70-C-0067
N74-13735	174-14774
N74-13736	DAAJ02-71-D-0003
¥74-13754	¥74-13731
N74-13755	DAAJ02-72-C-0040
¥74-13756	N74-14775
N74-13757	DAAJ02-72-C-0052
AP PROJ. 1369	874-14781
N74-14779	DAAJ02-72-C-0063
AF PROJ. 1476	N74-13729
#74-14746	DAAJ02-72-C-0075
AF PROJ. 3066	N74-13732
N74-14747	DAHC04-72-C-0040
	A74-18831
AF PROJ. 3145 N74-13903	DOT-FA71WA-2635
	N74-15380
AP PROJ. 6090 N74-14769	DOT-FA72WA-2800
	¥74+14340
AF PROJ. 7345 174-14246	N74-14341
AP PROJ. 7605	N74-14342
N74-15367	H74-14343
AF PROJ. 9711	N74-14344
N74-15666	DOT-FA72WA-2803
AF PROJ. 9778	¥74-15381
874-13746	¥74-15382
AP PROJECT 486U	N74-15383
A74-18738	N74-15384
AF-AF0SE-72-2274	H74-15385
174-16384	N74-15386
AF-AF0SE-72-2299	DOT-PA72WAI-242
A74-17905	N74-15379
AP-AFOSR-2200-72	F19628-73-C-0002
N74-14292	N74-15379
AF-AF0SR-2299-72	F33615-70-C-1450
H74-14292	H74-14747
AP-AFOSR-2365-72	#33615-70-C-1538
N74-15666	A74-16592
ARO PROJ. VF203	P33615-70-C-1647
N74-13992	A74-18139
ARG PROJ. VM5206	P33615-71-C-1508
N74-13992	N74-14779
ARPA OBDER 2108	P33615-71-C-1754
N74-13741	N74-13733
BMBW-BVII1-V17/72-KA-15	N74-13734
A74-17205	N74-13735
DA PROJ. 1F1-62201-A-119	N74-13736
174-14781	F33615-71-C-1760
DA PROJ. 1F1-62203-A-435	N74-13754
B74-14774	¥74−13755
DA PROJ. 1F1-62203-AA-33	N74-13756
874-13729	N74-13757
DA PROJ. 1F1-62205-A-119	P33615-71-C-1900
N74-13731	¥74-13903
DA PROJ. 161-62207-AA-71	P33615-72-C-1066
1174-14444	N74-14238
DA PROJ. 1G1-62207-AA-72	N74-14239
N74-13732	F33615-72-C-1362
#74-14775	B74-14746
DA PROJ. 182-62303-A-214	P33615-72-C-1450
¥74-14771	A74-17533

F33615-72-C-1891 A74-18738	
P33657-71-C-1055	
A74-18877 F33657-73-C-0058	
A74-18877 P44620-70-C-0105	
у74-13746 F44620-70-С+0116	
A74-18723	
N74-15115 NP51524005 N74-13742	
NASW-2481 N74-13707 NASW-2483 N74-13706	
N74-13717	
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